AVO INTERNATIONAL

INSTRUCTION MANUAL

For

UNIVERSAL PROTECTIVE RELAY TEST SET

MODEL SR-90

It is essential that this instruction book be read thoroughly before putting the equipment in service.

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This table lists alphabetically by type, relays covered by procedures in this manual.

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CHC	G.E. Fault Detector	80
CM	Westinghouse Current Phase Balance	62
CO	Westinghouse Voltage Controlled Overcurrent	21
COV	Westinghouse Voltage Controlled Overcurrent	52
CR	Westinghouse Directional Overcurrent	46
CV	Westinghouse Induction Disc Over/Under Voltage	25
HCB	Westinghouse Pilot Wire	74
HU	Westinghouse Harmonic Restraint Differential	55
IAC	G.E. Induction Disc Overcurrent	21
IAV	G.E. Induction Disc Over/Under Voltage	25

Relay	Section	Page
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IJC	G.E. Current Phase Balance	59
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IJD	G.E. Percentage Differential	28
IRD	Westinghouse Ground Directional Overcurrent	76
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KAB	Westinghouse High Impedance Bus Differential	66
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PVD	G.E. High Impedance Bus Differential	69
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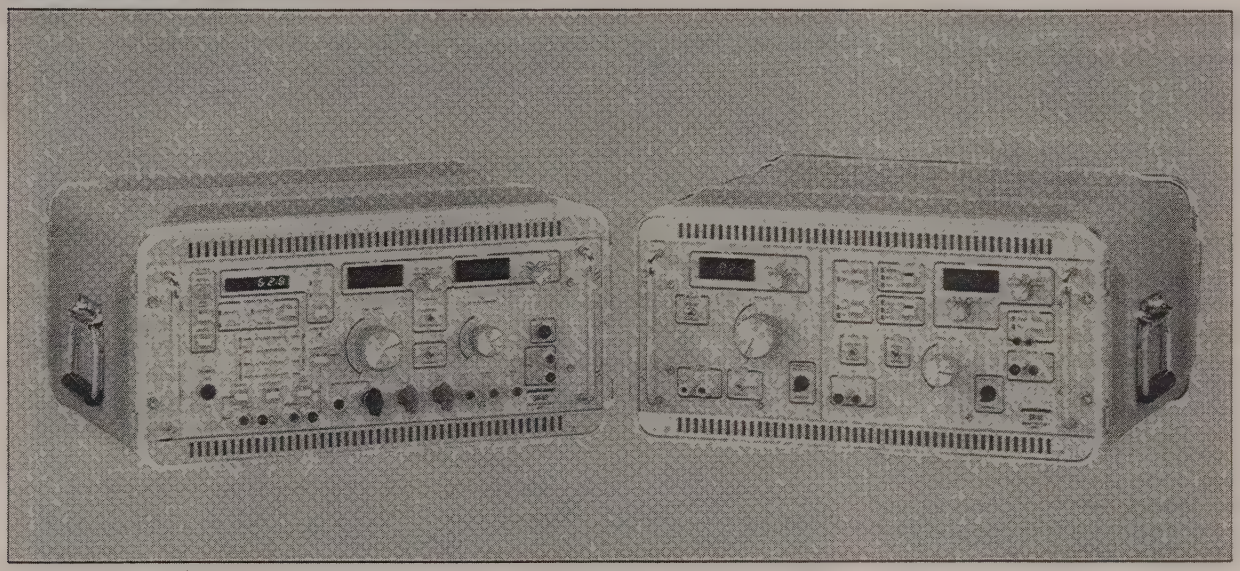


Universal Protective Relay Test Set

MULTI-AMP® Model SR-90

- **Digital metering**
- **Memory ammeter**
- **Units 1 and 2 work independently**

DESCRIPTION

The Multi-Amp® Model SR-90 Universal Protective Relay Test Set is a multipurpose, two-piece test set that accurately and efficiently tests electromechanical and solid-state protective relays.

Model SR-90 continues our commitment of providing you with a versatile, protective relay test set that is field portable and has sufficient power (1.4 kVA) for testing any protective device requiring up to 420 amperes.

Model SR-90 is designed so the main control section (Unit 1) and the auxiliary section (Unit 2) can be used independently from each other for testing "simple" protective devices.

To perform testing of more "complex" relays, Units 1 and 2 are easily interconnected to provide four simultaneous outputs of ac current or ac voltage, and dc current or dc voltage.

APPLICATIONS

Model SR-90 is designed for calibrating, acceptance testing and troubleshooting of protective relays, small molded- case circuit breakers and motor overload relays, and for timing circuit breakers. This test set is ideal for field, shop or laboratory use at utilities, manufacturing plants, commercial complexes or other facilities that perform preventative maintenance on electrical equipment.

Types of Relays You Can Test with Model SR-90

Table I - Unit 1

Relay Types	IEEE Device Number
Voltage-Controlled Overcurrent	27/51
Instantaneous Overcurrent	50
Overcurrent	51
Reclosing	79
Tripping	94
Molded-Case Circuit Breakers*	52
Motor Overload*	51/86

*The 140-ampere output tap may be overloaded up to three times its rating for short-time overloads.

Table II - Units 1 and 2

Relay Types (all of the protective relays in Table I plus:)	IEEE Device Number
Time Delay	2
DC Under/Overcurrent	37/76
Under/Overvoltage	27/59
Directional Overcurrent	67
Ground Directional Overcurrent	67N
Differential	87

Table III - Units 1 and 2
(with Model PSA-100 Combined Phase Shifter/Phase Angle Meter/Multimeter)

Relay Types	IEEE Device Number
Distance	21
Synchronizing	25
Directional Power	32
Negative Sequence Overcurrent	46

FEATURES AND BENEFITS

The Control Unit—Unit 1

Includes the main current transformer with five selectable current ranges of:

0 to 8.75 amperes at 0 to 160 volts
0 to 17.5 amperes at 0 to 80 volts
0 to 35 amperes at 0 to 40 volts
0 to 70 amperes at 0 to 20 volts
0 to 140 amperes at 0 to 10 volts

- Also features four selectable ammeter ranges of 2 amperes, 20 amperes, 200 amperes and 2 kA
- Memory ammeter: preset test currents when testing small, molded-case circuit breakers and motor overload relays. Reduces preheating the relay under test, thus avoiding the possibility of producing erroneous test current readings. Pinpoints instantaneous pickup points on overcurrent and current differential relays.
- Incorporates a metered voltage range of 0 to 160 volts using the 8.75-ampere tap with the ac voltmeter selectable to either 20 or 200 volts
- Selectable dc current or voltage is provided with output ranges of 2 amperes dc or 5 amperes dc and 150 Vdc or 300 Vdc.
- Solid-state, multifunction, digital timer

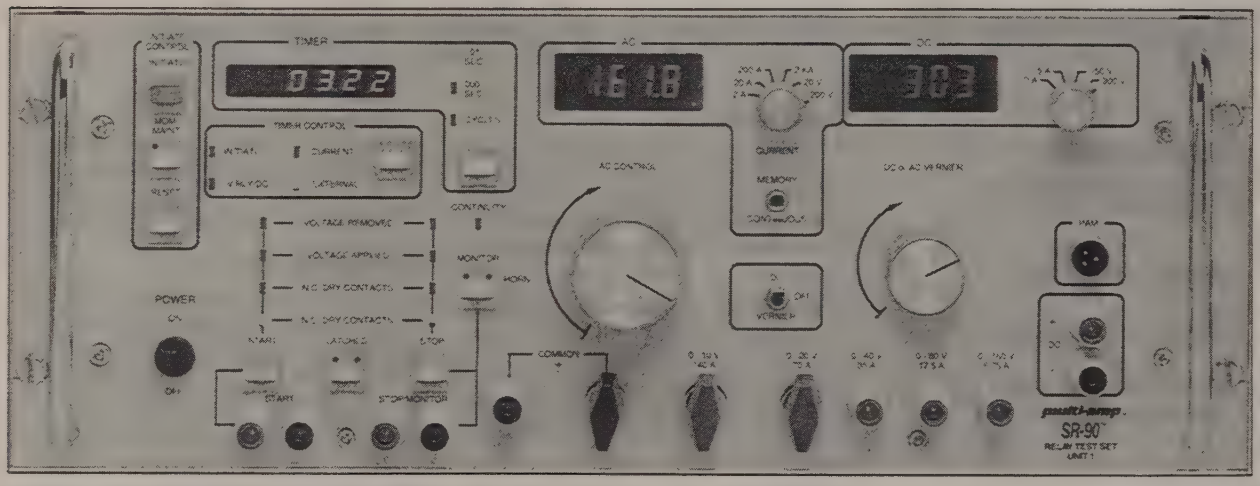
The Auxiliary Unit—Unit 2

Includes outputs for:

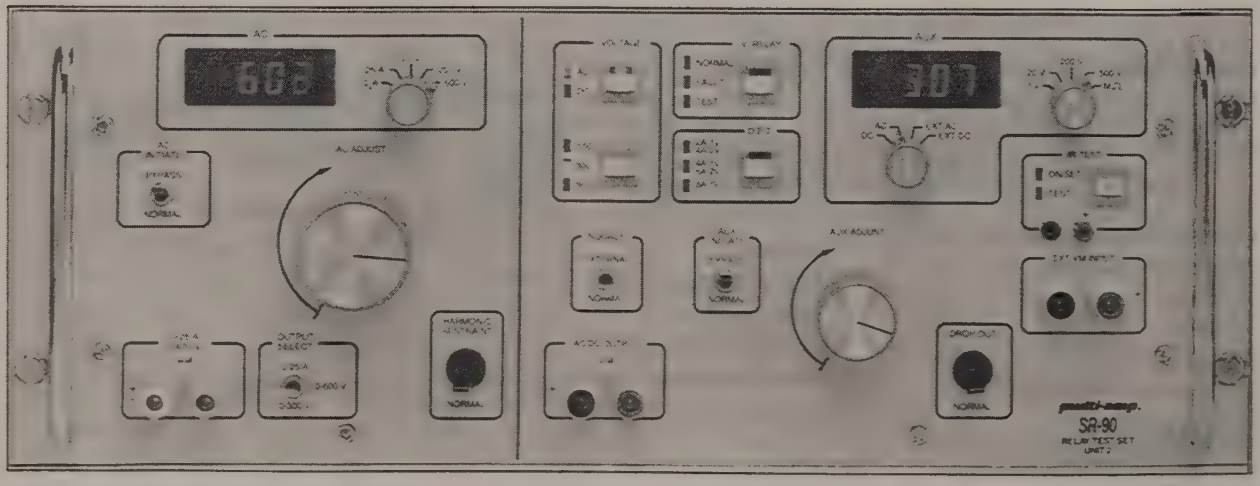
- Additional ac current source with a range of 0 to 25 amperes and ac voltage source with selectable ranges of 0 to 300 volts or 0 to 600 volts
- Harmonic restraint test source for providing half-wave rectified dc current from the 0- to 25-ampere output
- AC initiate switch for energizing the test set in normal mode (connected to Unit 1), or in the bypass mode when it is operating as a stand-alone unit

Also includes:

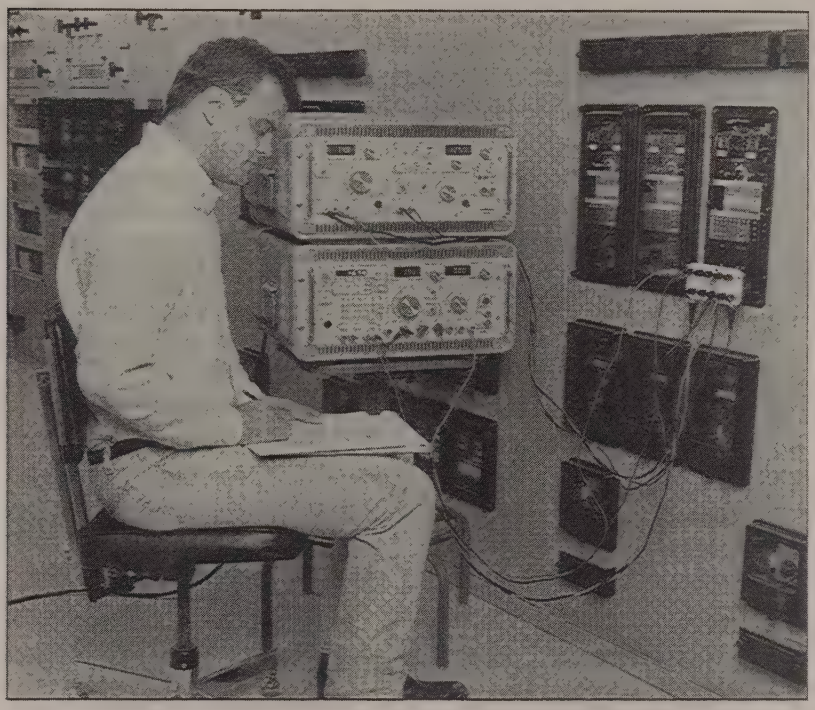
- An ac/dc voltage source, with selectable ranges of either 0 to 150 volts or 0 to 300 volts
- A voltage relay section for dynamic testing voltage relays
- A directional element test section for testing single-phase, directional elements. Five calibrated values are provided.
- The capacity to measure external ac or dc voltage when connected to Unit 2.
- A 500-Vdc insulation resistance test section



The Control Unit (Unit 1) of Model SR-90



The Auxiliary Unit (Unit 2) of Model SR-90



Model SR-90, with Units 1 and 2 stacked, tests a current differential relay in a panel.

Other Features and Benefits of Model SR-90

• High-accuracy, all-digital metering: avoids interpolation of readings associated with analog meters. This allows the user to be more productive by taking faster more accurate readings of voltage and current.

• Digital timer: Multifunction, switch-selectable timer increases accuracy and flexibility with independent start and stop gates. Eliminates the need for a separate timer for timing circuit breakers. Also, reclosing relays can be timed cumulatively.

• Easy-to-read, backlit LED displays: all-digital with $3\frac{1}{2}$-digit,0.5-in.(12-mm) displays. Current or voltage values can be read in all light levels, including direct sunlight and low-light conditions.

• Initiate control circuit: provides both "momentary" and "maintain" modes to control output duration. The momentary mode, in conjunction with the memory ammeter, permits "pulsed" application of the output to avoid damage or overheating of the relay while setting the test current.

In the maintain mode, the output remains energized until manually turned off, or when performing timing tests, until the relay under test operates, which stops the timer and de-energizes the output. Includes an external jack to initiate output away from the test set.

• Higher ac voltage output: Unit 2 features a 0- to 600-volt output terminal for testing relays rated up to 600 volts.

• Two high-capacity ac current outputs: designed to operate entirely independently of each other. One current channel provides five adjustable ranges, each rated at 1.4 kVA. The second channel is continuously adjustable from 0 to 25 amperes at 1 kVA — more than sufficient capacity to perform slope tests on high-impedance differential relays.

• EMI- and RF-shielding: reduces interference and prevents misoperation when using the test set in EHV switchyards and near portable, two-way radios

• Rack mountable: fixtures are provided so chassis can be installed in a standard, 19-in. (483-mm) rack.

• Environmentally tested: To simulate the worst field conditions possible, Model SR-90 has been tested and qualified in accordance with MIL-STD-810 for temperature, shock and vibration resistance. The units are forced-air cooled to extend operation of the test set in high ambient temperatures [will provide rated output at 122° F (50° C) for 5 minutes with an equal cool-down time].

• Rugged, weatherproof enclosure: Model SR-90 is available in a rugged, portable enclosure, or it may be ordered without the enclosure for easy mounting in a standard, 19-in. (483-mm) rack.

The ribbed enclosure is made of durable, medium-density, polyethylene plastic—flexible enough to absorb shocks and vibration, yet lightweight. The specially designed ribs add strength and protect the latches and handles during rough handling. The units are easily stacked with the ribs acting to interlock both units together.

The enclosure is completely weatherproof and noncorrosive. The gasketed tongue and grooved aluminum valance of the front and back lids and the lock-down, military-style latches protect the test set from dust and water intrusion. The front and back lids can be removed quickly when putting the unit into service, yet remain sealed and secure during transport or storage.

• Internal structure: Panel-mounted printed circuit boards with locking ribbon connections improve reliability and make Model SR-90 easy to service.

SPECIFICATIONS

Input

115 V ±10%, 50/60 Hz, 1ϕ
OR
230 V ±10%, 50/60 Hz, 1ϕ

Outputs

Unit 1

0 to 140 A ac at 10 V
0 to 70 A ac at 20 V
0 to 35 A ac at 40 V
0 to 17.5 A ac at 80 V
0 to 8.75 A ac at 160 V
0 to 5 A dc at 8 V
0 to 150 Vdc at 1.0 A
0 to 300 Vdc at 0.5 A

Unit 2

0 to 25 A ac at 40 V
0 to 300 Vac at 0.5 A
0 to 600 Vac at 0.25 A
0 to 150 Vac at 1.0 A
0 to 300 Vac at 0.5 A
0 to 150 Vdc at 1.0 A
0 to 300 Vdc at 0.5 A
0 to 500 Vdc

Instrumentation

Model SR-90 features all-digital instrumentation with 3½-digit, 0.5-in. (12-mm) backlit LED displays. All accuracies are stated for 10 to 100% of range.

Unit 1—Control Unit

AC Ammeter/Voltmeter

Ranges (switch-selected)

0 to 1.999/19.99/199.9/1999 A
0 to 19.99/199.9 V

Accuracy: ±1% of reading, ±1 digit

DC Ammeter/Voltmeter

Ranges (switch-selected)

0 to 1.999/5 A
0 to 199.9/300 V

Accuracy: ±1% of reading, ±1 digit

Unit 2—Auxiliary Unit

AC Ammeter/Voltmeter

Ranges (switch-selected)

0 to 1.999/25 A
0 to 19.99/199.9/600 V

Accuracy: ±1% of reading, ±1 digit

Multifunction AC/DC Voltmeter/Insulation Tester

Voltmeter also may be used as an independent instrument in conjunction with the voltmeter selector switch to measure external ac or dc voltages up to 300 V.

Ranges (switch-selected)

Voltage: 0 to 1.999/19.99/199.9/500 V

Accuracy: ±1% of reading, ±1 digit

Resistance: 0.1 to 19.99 MΩ

Timer—Unit 1

The solid-state, digital timer measures the elapsed time of the test in either seconds or cycles. Extensive shielding and noise-suppression circuitry is incorporated to ensure accurate and reliable operation under the most demanding field conditions. Also utilizes a crystal-controlled oscillator, allowing timer accuracy to be unaffected by the power line frequency

Display: 6-digit, 0.3-in. (7-mm) LED display

Ranges (switch-selected)

0 to 99.9999 s
0 to 9999.99 s
0 to 99999.9 cycles

Accuracy: ±0.005% of range, ±1 digit in the seconds mode; ±0.5 in cycles mode

Start/Stop Gates

Two independent pushbuttons provide these timer operating modes:

- Timer starts/stops when dry contact is opened/closed.
- Timer starts/stops when voltage is applied/removed; ac potential (60 to 300 V rms) or dc potential (5 to 300 V).
- Timer starts when output is initiated.
- Timer stops when output current is interrupted.

Latch On/Off

A four-function pushbutton is used with the start/stop pushbuttons and start/stop binding posts to increase control over starting and stopping the timer.

Operating Temperature

32 to 122° F (0 to 50° C)

Storage Temperature

–4 to +158° F (–20 to +70° C)

Dimensions

With Lids On

10.75 H x 21 W x 24.5 D in.
273 H x 533 W x 622 D mm

With Lids Off

10.75 H x 21 W x 18.5 D in.
273 H x 533 W x 470 D mm

Weight

With Lids On

Unit 1: 80 lb (36 kg)
Unit 2: 72 lb (33 kg)

With Lids Off

Unit 1: 74 lb (34 kg)
Unit 2: 66 lb (30 kg)

ORDERING INFORMATION

Item (Qty)	Cat. No.
Model SR-90 with 115-volt input, 50/60 Hz in standard enclosure	
Units 1 and 2	SR-90-115
Unit 1 only	SR-90-115-1
Unit 2 only	SR-90-115-2
Model SR-90 with 115-volt input, 50/60 Hz without enclosure, for rack mounting	
Units 1 and 2	SR-90-115/RK
Unit 1 only	SR-90-115-1/RK
Unit 2 only	SR-90-115-2/RK
Model SR-90 with 230-volt input, 50/60 Hz in standard enclosure	
Units 1 and 2	SR-90-230
Unit 1 only	SR-90-230-1
Unit 2 only	SR-90-230-2
Model SR-90 with 230-volt input, 50/60 Hz without enclosure, for rack mounting	
Units 1 and 2	SR-90-230/RK
Unit 1 only	SR-90-230-1/RK
Unit 2 only	SR-90-230-2/RK

Included Accessories

Carrying case for the following standard accessories below (1 per unit)	11437

Item (Qty)	Cat. No.
Cables	
Interconnect cable (1)	12681
Input power cable, Unit 1 (1)	12683
Input power cable, Unit 2 (1)	12684
Interconnect power cable (1)	12685
Remote initiate cable (1)	12806
Fuses	
0.5 A, 250 V (5)	982
1.0 A, 250 V (5)	4139
1.5 A, 250 V (5)	950
3 A, 250 V (5)	951
5 A, 250 V (5)	952
8 A, 250 V (5)	962
15 A, 250 V (5)	963
20 A, 250 V (5)	9043
Ground lead (1)	11258
Unit 1 test leads	
Current (1 pr)	7934
Voltage (2 pr)	1282
PAM Input (1 pr)	12680
Unit 2 test leads	
Current (1 pr)	7934
Voltage (2 pr)	1282
High-voltage leads (1 pr)	1125
Instruction manual (1)	12675

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THEORY OF OPERATION

Multi-Amp Model SR-90 is housed in a metal chassis shielded from EMI or RF interference. The ribbed enclosure is made of durable, medium-density polyethylene plastic, lightweight, yet flexible enough to absorb tremendous shock and vibration, each unit is equipped with carrying handles and removable hinged covers which protect instruments and controls during transportation and storage. A single multiple conductor cable with screw-in plugs on each end is provided to interconnect the two sections. Facilities are incorporated so that up to four independent outputs can be obtained simultaneously, with both units of the SR-90 interconnected and initiated simultaneously.

The control unit, Unit #1, incorporates the main current output transformer with selectable current ranges of 8.75A @ 0-160V; 17.5A @ 0-80V; 35A @ 0-40V; 70A @ 0-20V; and 140A @ 0-10V. The Ammeter range selection is either 2A; 20A; 200A; or 1KA. There is also a metered voltage range of 0-160V using the 8.75A @ 0-160V tap, with an AC Voltmeter selector switch selectable for either 20V or 200V. An additional section of selectable DC current or voltage is provided with output ranges of 2ADC, 5ADC or 150VDC, 300VDC, which is useful for testing target and seal-in units, operation indicators, DC voltage relays and providing DC logic voltage for solid-state protective relays. The control section also contains the primary initiate control circuitry of the test set along with the solid state digital timer, offering the user a multiple variety of timer options.

The auxiliary unit, Unit #2, contains outputs for an additional AC current source with a range of 0-25A, an AC voltage source with selectable sources of 0-300V or 0-600V, a Harmonic Restraint test switch, and an AC Initiate switch for selecting Normal operation of the test set when interconnected to Unit #1, (Normal Mode), or as a stand- alone unit, in the Bypass mode of operation. Unit #2 also incorporates an Auxiliary section with capabilities for an additional AC/DC voltage source, with selectable ranges of either 0-150V or 0-300V, a Voltage Relay section for dynamic testing of Voltage Relays, and a Directional Element Test section with five selectable values, an Insulation Resistance Test circuit, and the capacity to measure an external AC or DC voltage.

Model SR-90 is designed so that the main control section Unit #1 can be used independently from Unit #2, for the convenience in testing overcurrent relays and similar devices. To obtain the additional voltage or current sources for more 'complex' relays, both Unit #1 and Unit #2 must be interconnected.

DESCRIPTION OF CONTROLS AND INSTRUMENTATION

UNIT #1 - CONTROL SECTION

The Control Section, (Unit #1), of Model SR-90 comprises of two output channels; one is controlled by the large AC CONTROL knob and the other is controlled by the smaller DC or VERNIER knob. The following is a description of the controls and instrumentation on Unit #1.

FRONT PANEL

POWER ON/OFF Switch: Functions as main input switch for the test set.

INITIATE CONTROL Circuit: The Initiate Control Circuit of Model SR-90 provides the ability for Initiating the test set, establishing the mode of initiation either by energizing the circuit MOMENTARY or MAINTAINED and a RESET switch for resetting the digital timer.

INITIATE Button: The INITIATE button serves to start operation of the test set. A small LED above the button indicates whenever the test set is initiated.

MOM/MAINT Button: MOM. (Momentary):

The selected outputs will remain energized as long as the INITIATE switch is held depressed, until the contacts of the device under test close or the operator releases the INITIATE switch.

MAINT. (Maintain):

The function of this position is exactly the same as above except that the INITIATE button only needs to be depressed momentarily to lock-in a circuit which maintains the output of the test set. The test set will remain energized until the contacts under test change state or the operator depresses the RESET switch.

RESET Pushbutton:

It is always necessary to reset the Model SR-90 upon initial power up of the test set. This action will reset the digital timer to all zero. Therefore, should the test set fail to INITIATE upon depressing the INITIATE button, RESET the TIMER and then re-initiate the test set. Whenever the test set is in the MOM. mode it will be necessary to RESET the TIMER, due to an external operation of a contact closure from the protective device under test.

TIMER:

Used to measure the elapsed time of operation of the device under test. The Timer is equipped with a CYCLES/SECONDS Switch for selection of either a 0.01 seconds, 0.0001 seconds, or a cycles counting mode. Additionally, the RESET button is provided in the INITIATE CONTROL section, to reset the timer initiate circuitry and display.

TIMER CONTROL Section:

Selectable modes of operation convenient for the operator depending upon the type of test to be performed.

INITIATE

This function switch is the automatic default method of testing. Upon initiation of the Model SR-90 the TIMER will commence timing.

V.RLY/DO

This function switch should be used when performing timing tests on Under/Over Voltage Relays and timing the Drop Out of circuit breaker contacts or protective relay contacts.

CURRENT

This function switch is for testing current devices without allowing them to become damaged due to heating or performing time run performance tests. The current initiation point is set to trigger at approximately 8 degrees of the current sine wave, which equates to about 0.3703 milli seconds of current will be sensed by the current device under test, before the TIMER will actually start timing. The TIMER stops when the output current is interrupted by the device under test.

EXTERNAL

This function switch is selected for testing or monitoring external contacts, such as the 52a and 52b contacts of Low to EHV Circuit Breakers, the timing of protective relay protection schemes, conveyor control speed adjustments for coal feeders or material handling systems.

START/STOP Selector Pushbuttons:

Two identical independent four-position pushbutton switches are provided for selection of the Start and Stop/Monitor gates. The left pushbutton switch is used to select the Start gate operating mode, while the right pushbutton is used to select the Stop mode. In addition, the Stop Selector Switch is also used in conjunction with the Monitor Selector Switch for selecting the desired Monitor mode of operation. The following modes are provided for both the START gate and the STOP/MONITOR gate:

N.O. DRY CONTACTS:

The function of this position is to monitor contacts which have Normally Open Dry contacts of the device under test. The TIMER starts or stops at the closure of a normally open contact or conduction through a semiconductor device such as an SCR, triac or transistor.

N.C. DRY CONTACTS:

The function of this position is to monitor contacts which have Normally Closed Dry Contacts of the device under test. The TIMER starts or stops at the opening of a normally closed contact or when conduction through a semiconductor device such as an SCR, triac or transistor is interrupted.

VOLTAGE APPLIED:

The function of this position is to monitor contacts which have an AC/DC voltage across the contacts of the device under test. The TIMER starts or stops when an AC potential (60-300V RMS) or DC potential (5-300V) is applied.

VOLTAGE REMOVED:

The function of this position is to monitor contacts which have an AC/DC voltage removed from the

contacts of the device under test. The timer starts or stops when AC potential (60-300V RMS) or DC potential (5-300V) is removed.

LATCHED ON/OFF Pushbutton:

This four function pushbutton is used in conjunction with the START/STOP pushbuttons and the START/STOP binding posts in order to supervise the starting and stopping of the timer.

STOP LATCH:

When the stop circuit is latched ON the stop latch allows timing to be stopped at the first operation of any stop gate. When the STOP circuit is latched OFF, the stop latch allows timing to be stopped by any stop gate and then restarted if the stop gate reverses (provided a start gate is still energized) and stopped when the stop gate is again energized.

START LATCH:

When the start circuit is latched ON, the start latch allows timing to be initiated by any start gate and to be stopped only by the STOP gate selected. When the START circuit is latched OFF, the start latch allows timing to be initiated by any start gate and stopped when the start gate is reversed.

STOP/MONITOR Binding Posts:

These binding posts perform a dual function for monitoring a protective relay's trip circuit or as the STOP Gate of the digital timer. The trip circuit contacts of either an electromechanical relay or a solid state relay with or without a SCR voltage applied are connected.

MONITOR/HORN Pushbutton:

A CONTINUITY light or TONE generator can be used to monitor contact action or circuit continuity, when MONITOR/HORN LED's are illuminated the continuity light and the tone generator are turned ON. When the trip circuit connected to the STOP/MONITOR binding posts is closed, an audible tone is generated and the CONTINUITY light is illuminated. NOTE: when the MONITOR circuit is activated the HORN circuit is OFF, but when the HORN circuit is activated both the MONITOR circuit and the HORN circuit are ON.

AC Ammeter/Voltmeter:	Ammeter measures the AC output current. The meter is equipped with a CONTINUOUS or MEMORY switch. The CONTINUOUS position allows the meter to continuously display the current or voltage setting of the AC CONTROL Knob, the MEMORY position is utilized to set an instantaneous current level, using the MOM, INITIATE control switch, for testing instantaneous relays, pre-setting current levels for time testing of overcurrent devices, and testing current differential relays. The Voltmeter is connected to the 8.75A @ 160V output tap to meter the voltage output.
AC Ammeter/Voltmeter Range Switch:	Selects full scale range of the AC Ammeter/Voltmeter. For highest resolution, always use the lowest range which will not over-range the meter.
DC Ammeter/Voltmeter:	Measures the DC output current or voltage.
DC Ammeter/Voltmeter Range Switch:	Selects full scale range of the DC ammeter or voltmeter.
DC or VERNIER Control Knob and DC/VERNIER Switch:	When the DC/VERNIER Switch is in the DC position, this knob controls the DC CURRENT or VOLTAGE output. When in the VERNIER position, it is a fine-adjustment for the main AC CURRENT or VOLTAGE output.

DC Output Binding Posts (Red +, Black -): Binding posts for the DC CURRENT or VOLTAGE output.

AC CONTROL Knob: This knob controls the main AC current output of Unit #1. The AC CONTROL Knob also performs a dual function to provide either AC Current or Voltage.

AC Output Terminals: The output controlled by the main AC control knob is available at the terminals located at the bottom of Unit #1. There are two common terminals and five output ranges. Each range can be used either as source of AC voltage or AC current, but only the 8.75A @ 0-160V tap is metered on the AC Voltmeter located directly above the AC Control knob. All other taps can be utilized as an AC Voltage source, but the operator must use an external voltmeter for monitoring the voltage applied.

Each range is capable of supplying the indicated current, provided the voltage is sufficient to push the current through the impedance of the load circuit. Where the voltage is sufficient to "push" higher than rated current through the impedance of the load circuit, the current ratings are designed to be overloaded for short durations. For overload capabilities, refer to the OVERLOAD CAPABILITY OF UNIT #1 section of this manual.

P.A.M. Output: This output provides a 10 to 30 volt output to a voltage coil of a phase angle meter. Note: This is a voltage output and *not* a current input which was the design concept for previous SR units. It should also be noted that this voltage is in-phase with the AC current output of Unit #1.

WARNING:

DO NOT apply this output to a phase angle meter current coil.

UNIT #1 - BACK PANEL

Input Line Cord: The test set is equipped with a standard 3-prong line cord which is part of the accessory kit, it connects to the male plug on the back panel of Unit #1. The nameplate should be checked for verification of input voltage before connecting the line cord to the source of power.

UNIT #2 AC POWER:	This receptacle is used when Unit #1 is to be connected with Unit #2 and input voltage from Unit #1 is supplied to Unit #2.
UNIT #2 INTERCONNECT:	This receptacle is used when Unit #1 is to be connected with Unit #2 and the INITIATE CONTROL, the TIMER, or the TIMER CONTROL circuitry of Unit #1 is to be utilized to compliment Unit #2.
FREQUENCY Select Switch:	This switch is equipped on Unit #1 to select the frequency time base for the TIMER, at either 50 or 60 Hz, and the input voltage frequency.
EXT. INITIATE Jack:	The test set can be initiated from a remote location by closing a circuit plugged into the EXT. INITIATE jack.
120V SYNC. Binding Posts:	These terminals are energized with 120 volts whenever the unit is initiated. This voltage may be used as a control source to initiate an external device such as an auxiliary relay.
Fuses - 115V, [230V]	
F1 - 15A, [10A]	Protects the AC CONTROL Output Transformer and the wiper arm of the AC CONTROL variable transformer.
F2 - 3A, [1.5A]	Protects the AC/DC VERNIER Output Transformer and the wiper arm of the AC/DC VERNIER variable transformer.
F3 & F6 - 5A, [2A]	Provides overload and short-circuit protection for the main AC output circuit.
F4 - 1A, [0.5A]	Protects the line input filter from abnormal current surges.
F5 - 0.5A, [0.5A]	Provides overload and short-circuit protection for the main control logic printed circuit board.
F7 & F8 - 20A, [10A]	Provides overload and short-circuit protection for the entire test set and its connection to the users AC voltage distribution outlet.
F9 - 5A, [5A]	Protects the full wave bridge rectifier circuitry necessary for generating the DC voltage output.

UNIT #2 - AUXILIARY SECTION

The Auxiliary Section, (Unit #2), of Model SR-90 comprises of two output channels on the test set; one controlled by a large AC ADJUST Control knob and the other by a small AUX ADJUST Control knob. The following section provides a description of the various controls and instrumentation in the Auxiliary Section, (Unit #2), of Model SR-90.

AC Ammeter/Voltmeter:	Measures the magnitude of the 0-25A, 0-300V, or 0-600V output available at the Blue and White output binding posts.
AC Ammeter/Voltmeter Range Switch:	Selects full scale range of the AC Ammeter/Voltmeter. For highest resolution, always use the lowest range which will not over-range the meter.
AC INITIATE BYPASS/NORMAL Switch:	This switch is used to establish the Initiate Control circuitry for the 0-25A/0-600V output. When the switch is in the NORMAL position the 0-25A/0-600V output is energized by the INITIATE CONTROL circuitry of Unit #1. When the switch is in the CENTER position the 0-25A/0-600V output is OFF, if switched to the BYPASS position the 0-25A/0-600V output is ON.
	WARNING **IF THE RED LED ABOVE THE 0-25A/0-600V BINDING POSTS IS ILLUMINATED, THE CHANNEL IS ON. IF THE RED LED IS FLASHING, THE CURRENT CIRCUIT UNDER TEST IS OPEN OR THE VOLTAGE CIRCUIT UNDER TEST IS SHUNT. IF UNIT #2 IS NOT INTERCONNECTED TO UNIT #1, IN ORDER TO REESTABLISH THE OUTPUT, MOVE THE AC INITIATE SWITCH TO THE CENTER POSITION AND BACK TO THE BYPASS POSITION.**
OUTPUT SELECT Switch 0-25A/0-300V/0-600V:	This switch is used to select either a current output of 0 to 25 amperes at 40 volts, a voltage output of 0 to 300 volts at 1.0 amperes, or a voltage output of 0 to 600 volts at 0.5 amperes; the current or voltage output is available at the Blue and White output binding posts labeled **0-25A** or **0-600V** AC. The White binding post is the instantaneous (±) polarity binding post.

CAUTION:
THIS IS AN INTERLOCKING SWITCH. PULL THE SELECTION SWITCH OUTWARDS,THEN MOVE TO THE DESIRED POSITION AND RELEASE.

AC ADJUST Control Knob: This knob allows the user to adjust the AC Current or Voltage output of Unit #2.

HARMONIC RESTRAINT/NORMAL Switch: In the NORMAL position, the HARMONIC RESTRAINT circuitry is completely isolated. When switched to the HARMONIC RESTRAINT position, the 0 to 25A Output terminals of Unit #2 will provide a half-wave rectified DC current output for testing the harmonic restraint element in harmonic restraint differential relays. The output magnitude is controlled by the large AC ADJUST Control knob of Unit #2, while the amplitude of the half-wave rectified DC current is displayed on the DC Ammeter of Unit #1. NOTE: The DC Ammeter Selector Switch on Unit #1 must be set at 5A.

AUXILIARY OUTPUT SECTION

VOLTAGE SECTION:

0-150V DC: 0-150V DC @ 1.0 amperes is available at the AC/DC OUTPUT binding posts.

0-300V DC: 0-300V DC @ 0.5 amperes is available at the AC/DC OUTPUT binding posts.

0-150V AC: 0-150V AC @ 1.0 amperes is available at the AC/DC OUTPUT binding posts. The Black binding post is the (±) instantaneous polarity binding post.

0-300V AC: 0-300V AC @ 0.5 amperes is available at the AC/DC OUTPUT binding posts. The Black binding post is the (±) instantaneous polarity binding post.

IR TEST: 0-500 volts DC for measuring insulation resistance. The output is available at the small Red and Black pin sockets labeled IR TEST and is controlled by the AUX ADJUST knob.

V. RELAY SECTION: Used in conjunction with the voltage relay and directional element test circuits. The functions of each position are detailed as follows:

NORMAL: Used to apply the normal relay voltage to the voltage relay under test. The output is available at the AC/DC OUTPUT binding posts, displayed on the AC Voltmeter, and is controlled by the AC ADJUST control knob.

FAULT: Used to preset the fault voltage to be applied to voltage relay under test. When in this position, the normal voltage set in the NORMAL position remains on the relay. The magnitude of the fault voltage is controlled by the AUX ADJUST control knob and is displayed on the AUX Voltmeter.

TEST: The fault voltage, which was preset in the V. RLY. FAULT position, is applied to the relay and the digital timer is simultaneously started, provided the TIMER CONTROL selection has been preset to the V.RLY/DO position. When the relay operates, the timer will stop.

D.E.T. Section: Five ranges are provided to conduct pickup tests on directional elements. To obtain a voltage and a current exactly in phase, the instantaneous polarity terminal of the relay's current coil is connected to the Blue 0-25A or 0-600V AC binding post. The non-polarity terminal is connected to the Black AUXILIARY OUTPUTS binding post. The instantaneous polarity terminal of the relay's potential coil is connected to the Black AUXILIARY OUTPUTS binding post and the non-polarity terminal is connected to the Red AUXILIARY OUTPUTS binding post.

The magnitude of the voltage and current is controlled by the AC ADJUST Control knob, the current magnitude is displayed in the AC Ammeter and the voltage amplitude is displayed in the AUX Voltmeter.

Reversing either the current coil or the potential coil connections will result in the current and potential being 180° out of phase.

AUX VOLTMETER SECTION

AUX AC/DC Voltmeter: Used in conjunction with the VOLTMETER CIRCUIT SELECTOR Switch and the VOLTMETER RANGE Switch, the magnitude of the various potential outputs of the test set, or of an external AC or DC potential may be measured.

AUX Voltage Range Pushbutton Switch:

Selects the full scale range of the AC/DC voltmeter. Always use the lowest range which will not over-range the meter.

AUX Voltage Selector Pushbutton Switch:

Used to select the circuit whose potential is to be measured by the AC/DC VOLTMETER. A description of each position follows:

DC: Measures the DC Voltage output of the AUX Section at the AC/DC output binding posts.

AC: Measures the AC Voltage output of the AUX Section at the AC/DC output binding posts.

EXT. AC: Used to measure an external AC potential applied to the Red and Black binding posts on the BACK PANEL.

EXT. DC: Used to measure an external DC potential applied to the Red and Black binding posts on the BACK PANEL.

NORMAL/DROPOUT Switch:

Used to perform a dropout timing test on an AC or DC auxiliary relay. When the switch is changed from the NORMAL to the DROPOUT position, the relay under test is de-energized and the digital timer is simultaneously started, provided the operator has preset the TIMER CONTROL selection to the V.RLY/DO position.

SOURCE NORMAL/EXTERNAL Switch:

Selects whether the AUXILIARY OUTPUTS variable autotransformer is energized from an internal (NORMAL) or an external source. When it is desirable to energize from an external source of power (not over 120 volts AC) such as a phase shifter or frequency generator, the source is connected to the Yellow and White (±) binding posts. The potential is then controlled by the AUXILIARY OUTPUTS knob.

AUX INITIATE NORMAL/BYPASS Switch:

This switch is used in conjunction with the AUX. OUTPUT in order to utilize Unit #2 in conjunction with Unit #1, or as a stand alone unit. When in the NORMAL position, output can be obtained from initiating Unit #1. When in the BYPASS position Unit #2 is initiated and the AUX AC/DC Voltage outputs can be adjusted from the AUXILIARY Section of Unit #2.

NOTE: **The center position of this switch is the OFF position, when using Unit #2 interconnected to Unit #1 the switch should be in the NORMAL position. When using Unit #2 as a stand alone unit the switch should be in the CENTER or OFF position and switched from OFF to BYPASS to initiate the AUXILIARY Section of Unit #2.**

IR TEST Switch and Output Pins:

Used in conjunction with the VOLTAGE Selector Switch and AUX ADJUST Control knob, the AUX voltmeter, and the AUX Voltmeter range switch.

The IR TEST is first setup by depressing the bottom switch of the VOLTAGE Section until a red LED is illuminated adjacent to the position IR. The AUX ADJUST Control knob is used to calibrate the Megohm range on the AC/DC voltmeter to the infinity calibration mark with the SET/TEST Switch in the SET position. In the TEST position, 500 volts DC is applied and the insulation resistance is indicated on the AC/DC voltmeter. The output is available at the small Red (+) and Black (-) output pins.

UNIT #2 - BACK PANEL

Fuses - 115V, [230V]

F1 - 1.5A, [0.5A]	Protects the input line filter from abnormal current surges and short-circuits.
F2 - 3A, [1.5A]	Provides protection for the AUX ADJUST output transformer and the wiper arm of the AUX ADJUST variable transformer.
F3 - 8A, [5A]	Protects the 0 to 25A, 0 to 300V, or 0 to 600V AC output channel.
F4 & F5 - 5A, [2A]	Provides protection to Unit #2 when an EXTERNAL AC/DC Voltage is injected into the test set.
F6 & F7 - 15A, [7A]	Provides overload and short-circuit protection for the test set and is connection to either Unit #1, or the users AC voltage distribution outlet.
F8 - 5A, [5A]	Protects the diode circuitry necessary for generating the half wave rectified DC current in conjunction with the Harmonic Restraint Switch.
EXT. INPUT POWER:	These two binding posts, yellow and white, with white being the instantaneous (+/-) polarity terminal, are to be used in conjunction with the Source External/Normal Switch. These binding posts are used, when it is desirable to energize Unit #2 of the SR-90 from an external source of power such as a frequency generator or a phase shifter.
INPUT LINE RECEPTACLE:	A three-prong CSA, IEC, and UL approved receptacle is provided for connection of Unit #2 to Unit #1.
POWER ON/OFF SWITCH:	This toggle switch is provided to initially turn the test set on to eliminate any confusion regarding the use of INITIATE CONTROL circuitry in either the NORMAL or BYPASS mode of operation.
GND. POST:	This binding post is necessary to establish a common grounding point in addition to the ground supplied by the INPUT LINE CORD between Unit #2 and Unit #1.
UNIT #1 INTERCONNECT RECEPTACLE:	This 14 pin receptacle is provided to interconnect Unit #2 with Unit #1 in order to gain complimentary circuitry as noted in this manual.

SELECTION OF OUTPUT TAPS

Unit #1 has several output terminals at various voltage and current ratings provided to adapt the SR-90 to a wide variety of test circuit impedances. The test set works at its peak efficiency when the outputs are used at or slightly above their ratings, (for overload capability see page 19). In this way, finer adjustment can be obtained by making maximum use of the variable auto transformer. The LOWER CURRENT terminals should be used when testing high impedance devices, where the rated current terminals do not have sufficient voltage to "push" the desired test current through the relay under test, without waveform distortion, use the next LOWER CURRENT terminal to avoid waveform distortion by doubling the voltage and having twice the voltage to "push" up to three times the rated output of current.

IT SHOULD BE NOTED THAT THERE IS NO RELATIONSHIP BETWEEN THE AMMETER RANGES AND THE CURRENT TAPS. ANY AMMETER RANGE CAN BE USED ON ANY TAP.

SERVICE DATA

Multi-Amp Model SR-90 uses straight forward circuits and components requiring little or no routine servicing except for cleanliness.

The following maintenance is recommended:

1. Open the unit every six months and examine for:
   a. Dirt
   b. Moisture
   c. Corrosion
   d. Condition of relay contacts

2. Remove dirt with dry compressed air.

3. Remove moisture by opening unit as much as possible and putting it in a warm dry environment.

4. As corrosion may take many forms, no specific recommendations can be made for its removal.

If factory service is required or desired, contact the factory for return instructions.

A Return Authorization (RA) number will be assigned for proper handling of the unit when it arrives at the factory.

If desired, a letter with the number and instructions can be provided.

Provide the factory with model number, serial number, nature of the problem or service desired, return address, your name, and where you can be reached should the factory need to contact you.

A purchase order number, cost limit, billing, and return shipping instructions may also be provided if desired.

National Institute of Standards and Technology recommends traceable calibration and certification once a year. Calibration and certification of two types is available if desired at an additional cost.

CLASS ONE: A certificate is provided verifying the traceability and calibration of the equipment.

CLASS N: That which is required for nuclear power plants. A certificate of traceability and calibration along with "as found" and "as left" data are provided.

If an estimate is requested, provide the name and contact information of the person with approval/disapproval authority.

Pack the equipment appropriately to prevent damage during shipment. If a reusable crate or container is used, the unit will be returned in it if in suitable condition.

Put the RA number on the address label of the shipping container for proper identification and faster handling.

WARRANTY

Multi-Amp Corporation warrants to the original purchaser that the product is free of defects in material and workmanship for a period of one (1) year from date of shipment. This warranty is limited and shall not apply to equipment which has damage, or cause of defect, due to accident, negligence, improper operation, faulty installation by the purchaser, or improper service or repair by any person, company or corporation not authorized by Multi-Amp Corporation.

Multi-Amp Corporation will, at its option, either repair or replace those parts and/or materials that it deems to be defective. Any costs incurred by the purchaser for the repair or replacement of such parts and/or materials shall be the sole responsibility of the original purchaser.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED ON THE PART OF THE MULTI-AMP CORPORATION, AND IN NO EVENT SHALL THE MULTI-AMP CORPORATION BE LIABLE FOR THE CONSEQUENTIAL DAMAGES DUE TO THE BREACH THEREOF.

OVERLOAD CAPABILITY OF UNIT #1

The Model SR-90, Unit #1, incorporates five current output ranges which are designed to utilize the main output transformer's overload capability, provided the output voltage is sufficient to "push" the output current through the impedance of the load circuit. Where the output voltage is sufficient to "push" more than rated output current, each current range may be overloaded for short durations of time, in accordance with the table below. Fuse protection is incorporated to prevent overloading provided the proper fuse size is used and that the Minimum OFF times are observed to avoid the possibility of damaging the output transformer and/or the variable autotransformer. When the "ON" time is less than the times indicated below, the time "OFF" time can be proportionally reduced.

	Current	Maximum Time ON	Minimum Time OFF
10-Volt, 140-Ampere Range			
	140A	5 min.	30 min.
	280A	75 sec.	30 min.
	320A	30 sec.	30 min.
20-Volt, 70-Ampere Range			
	70A	5 min.	30 min.
	140A	75 sec.	30 min.
	210A	30 sec.	30 min.
40-Volt, 35-Ampere Range			
	35A	15 min.	30 min.
	70A	3 min.	8 min.
	105A	30 sec.	4 min.
80-Volt, 17.5-Ampere Range			
	17.5A	15 min.	30 min.
	35.0A	3 min.	8 min.
	50.0A	30 sec.	4 min.
160-Volt, 8.75-Ampere Range			
	8.75A	15 min.	30 min.
	17.5A	3 min.	8 min.
	25.0A	30 sec.	4 min.

OVERLOAD CAPABILITY OF THE 0-25 AMPERE OUTPUT OF UNIT #2

The 0 to 25 ampere output channel of Unit #2 has the capability of being overloaded at 37.5 amperes with a duty cycle of 5 minutes **ON** and 30 minutes **OFF**.

TESTING PROTECTIVE DEVICES WITH THE SR-90 TIMER

The following procedure outlines a generic and efficient manner to consecutively perform various tests with the TIMER on Unit #1 of the SR-90. There are literally hundreds of testing applications for the TIMER in the Model SR-90. There are 48 control function combinations and 3 timer mode selections. Once the operation of the TIMER is thoroughly understood, the operator can easily construct a test procedure for each application encountered. Various procedures could be suggested by Multi-Amp, but the correct method of timing various devices depends entirely on the recommendations of the manufacturer of the device and the preferences of the operator or the organization that establishes the standards for performing such tests.

General Test Procedure:

1. Connect the SR-90 to a suitable source of power.

2. Switch the POWER ON/OFF Switch to ON.

3. Switch the START Selector Pushbutton Switch to the desired position for the START function to be used.

4. When it is desired to use a separate STOP gate signal to stop the timer, switch the STOP Selector Switch to the desired position.

5. Switch the LATCHED Switch to the desired position for the START/STOP gates. If it is desired to use a separate STOP function to stop operation of the TIMER, switch the START LATCH ON. If it is desired to use the reversal of the START signal to stop the timer switch the START LATCH OFF.

6. Switch the SEC/CYCLES Switch to the desired position.

7. Make the necessary connections to the START and STOP/MONITOR binding posts.

8. When the appropriate START and STOP signals are applied, the display indicates the elapsed time of the test.

NOTE: Always RESET the TIMER before each timing test to assure all logic circuits are in the correct state, even when the display registers zero. This is especially recommended when any switch positions are changed.

TESTING INDUCTION DISC OVERCURRENT RELAYS
Westinghouse Type CO
General Electric Type IAC

The following procedure outlines the most efficient manner to consecutively perform all tests on an overcurrent relay. This procedure involves the least possible number of changes in connecting test leads and setting test set controls.

Always refer to the instruction book of the relay being tested to ascertain the manufacturer's recommendations for accuracy limits, adjusting procedures, etc.

Unit #1 of Model SR-90 can be used independently of Unit #2 for conducting all of the following tests:

Zero check
Pickup - Induction Unit
Timing - Induction Unit
DC Target and Seal-In
Pickup - Instantaneous Unit

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
MONITOR/HORN Switch	Either position
AC CONTROL Knob	"0"
DC/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	Set to read test current in upper section of meter scale
DC or VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

ZERO CHECK

This test is usually performed on a new relay to determine that the relay contacts close when the time dial is set to zero. If an "As Found Test" is to be performed on the relay, do not perform the zero check.

1. Connect light leads from binding posts marked STOP/MONITOR to trip circuit contact terminals of the relay induction unit.

2. Manually rotate time dial on the relay toward zero until the continuity light glows or tone signal sounds. Record reading on time dial.

3. Adjust for any irregularities uncovered and return time dial to specified setting.

PICKUP - INDUCTION UNIT

This test is to determine the minimum operating current of the relay; that is, the minimum current needed to close the relay contacts for any particular tap setting. Most manufacturers specify that the pickup current should be equal to tap value ± 5%.

1. Connect induction unit operating coil of relay to the COMMON (±) and 17.5A terminals (use 8.75A terminal for ground relays, i.e., those with tap ranges of 0.5 - 2A).

2. Set AC AMMETER RANGE Switch so that the anticipated pickup current (relay tap value) will be read in upper 1/3 section of ammeter scale.

3. Initiate unit by pressing INITIATE Switch.

4. Rotate AC CONTROL knob (clockwise) to increase output until relay picks up and continuity light flickers or tone signal wavers. VERNIER control may be used for fine adjustment.

5. Read current on ammeter. Record.

6. Return both AC CONTROL knob and VERNIER Control knob to "0" and de-initiate test set.

TIMING TEST - INDUCTION UNIT

1. Set INITIATE CONTROL, MOM/MAINT switch to MOM.

2. Set AC AMMETER RANGE Switch so that test current will be read in upper section of meter scale.

   NOTE: See AMMETER CIRCUIT section for instructions on use of CURRENT MEMORY.

3. Initiate unit by pressing INITIATE button.

4. Set desired test current by jogging unit with INITIATE Switch and rotating AC CONTROL knob (clockwise) to increase output until ammeter setting is reached. Hold in INITIATE Switch and rotate VERNIER control to make final current adjustment.

5. Set TIMER CONTROL to INITIATE position.

6. Reset TIMER to zero with RESET button.

7. Initiate unit by pressing INITIATE button. TIMER will count and test current will flow. The test set will automatically shut off and the timer will stop when relay operates.

   NOTE: Check ammeter while test is on. Minor adjustment may be made with VERNIER control.

8. Read TIMER. Time shown is total time of test. Record time.

9. If it is desired to obtain another point of relay curve, reset TIMER and proceed from Step 2.

10. When test is concluded, return AC CONTROL knob and AC VERNIER to "0" and de-initiate test set.

TESTING DC TARGET AND SEAL-IN

1. Remove test leads from STOP/MONITOR binding posts and connect to [±] DC binding posts.

2. Select proper range for DC ammeter with the DC AMMETER RANGE Switch.

3. Set DC/VERNIER Switch to DC.

4. Select proper range for AC ammeter so that a current of approximately 150% of the relay tap value may be read in the upper section of the meter scale.

5. Initiate test unit by pressing INITIATE button.

6. Rotate AC CONTROL knob clockwise to energize induction unit operating coil of relay with a current equal to approximately 150% of the tap value. This is simply to make the relay operate and complete the trip circuit.

7. When the induction unit trip circuit contacts of the relay close, slowly rotate the DC VERNIER control knob clockwise to energize target coil of relay with DC. When target drops, read and record DC amperes.

8. Rotate AC CONTROL knob counterclockwise to zero. If the DC circuit remains energized when the induction unit trip circuit contacts of relay open, the seal-in unit is working properly.

9. Gradually rotate the VERNIER control knob counterclockwise toward zero, when the target coil of the relay drops out to its normally open position read and record the DC amperes. This is the Drop Out value of the Target and Seal-in relay. Turn test set OFF.

TESTING INSTANTANEOUS PICKUP

1. Connect instantaneous unit operating coil of relay to the COMMON [±] and 140A terminal of test set.

2. Connect instantaneous unit trip circuit contacts of relay to the STOP/MONITOR binding posts of test set.

3. Set AC AMMETER RANGE Switch so that anticipated instantaneous test current will be read in upper section of meter scale.

4. Set DC/VERNIER Switch to VERNIER.

5. Set INITIATE CONTROL, MOM/MAINT switch to MOM.

6. Set CURRENT MEMORY/CONTINUOUS switch to MEMORY. Initiate unit by depressing the INITIATE switch.

7. Rotate AC CONTROL knob clockwise to increase current until the continuity light glows or tone signal sounds. Make sure this is *minimum setting* on the AC CONTROL where the instantaneous unit of the relay will consistently pickup as the INITIATE button is alternately opened and closed. The glowing of the continuity light or the tone signal should be simultaneous with the depression of the INITIATE button.

8. Rapidly read this value of current and release INITIATE button.

WARNING

CURRENT IS FLOWING THROUGH THE RELAY COIL UNTIL INITIATE BUTTON IS RELEASED.

9. Record ammeter reading.

10. Return all Control knobs to "0" and de-initiate test set.

TESTING OVER/UNDER VOLTAGE RELAYS
Westinghouse Type CV
General Electric Type IAV

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
TIMER CONTROL	V.RLY/DO
MONITOR/HORN Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER/VOLTMETER Switch	200V
DC or AC VERNIER CONTROL Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

0-25A/0-600V Output Select Switch	0-300 V
AC VOLTMETER RANGE Switch	So that the desired test voltage will be read in upper 1/3 of scale.
AC INITIATE Switch	NORMAL.
AC ADJUST Control Knob	"0"
HARMONIC RESTRAINT/NORMAL Switch	NORMAL.
V. RELAY Switch	NORMAL.
AUX AC VOLTMETER CIRCUIT SELECTOR Switch	So that the desired test voltage will be read in upper 1/3 of scale.
AUX ADJUST Control Knob	"0"

AUX VOLTAGE Selector Switch	150V AC or 300V AC (depending on nominal operating voltage of the relay).
NORM./DROPOUT Switch	NORMAL.
SOURCE	NORMAL.
AUX INITIATE Switch	NORMAL.

TESTING FOR PICKUP

1. Connect the relay operating coil to the AC/DC OUTPUT, Red and Black binding posts of Unit #2 AUXILIARY Section.

2. Connect light leads from binding posts marked STOP/MONITOR of Unit #1, to the trip circuit contact terminals of the relay induction unit.

3. Set INITIATE CONTROL, MOM/MAINT to MAINT, on Unit #1.

4. Initiate test set by pressing the INITIATE Switch.

5. Rotate the AC ADJUST Control Knob, of Unit #2, (clockwise) to increase output until CONTINUITY light flickers or the TONE generator output breaks.

6. Record this value of voltage as pickup of the relay.

TESTING TIMING

UNIT #1

7. De-Initiate UNIT #1. Set TIMER CONTROL to V.RLY/DO position.

   OPTIONAL: Select TIMER for 0.01 seconds, (default), 0.0001 seconds or cycles mode.

UNIT #2

8. Set AC INITIATE SWITCH to BYPASS and AUX INITIATE Switch to BYPASS.

9. Set V. RELAY Section switch to NORMAL, Voltage section defaults to AC and operator chooses 150V or 300V range.

10. Rotate the AC ADJUST Control Knob (clockwise) to increase output until normal relay voltage (see relay nameplate) is observed on voltmeter.

11. Switch the V. RELAY Test Switch to FAULT position.

12. Set faulted relay voltage by rotating AUX ADJUST Control Knob to increase or decrease output. Read the fault voltage on the voltmeter.

    NOTE: Set the fault voltage approximately one to two volts higher than the desired test voltage.

13. Switch the V. RELAY Test Switch to the TEST position. The fault voltage will be impressed on the relay operating coil and the digital timer will automatically start.

14. When the relay trip circuit contacts make, the timer will stop to indicate the elapsed time of the test.

15. If a retest is desired, return the V. RELAY Test Switch to NORMAL. Reset TIMER, and repeat Steps 9 through 14 for the other values of fault voltage.

TESTING DC TARGET AND SEAL-IN

16. The DC TARGET and SEAL-IN unit can be tested following the procedure given in the test procedures for testing an overcurrent relay.

TESTING PERCENTAGE DIFFERENTIAL RELAYS
Westinghouse Type CA
General Electric Type IJD

TYPES OF TESTS

Pickup
Time Current Characteristic
Through Fault
Slope

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	So that the desired test current can be read in the upper 1/3 of the scale.
DC VERNIER/Switch	VERNIER
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/0-600V AC Switch	0-25A
AC AMMETER RANGE Switch	So that the desired test current can be read in UPPER 1/3 of scale
AC ADJUST Control Knob	"0"
HARMONIC RESTRAINT/NORMAL Switch	NORMAL

NORMAL/EXT. POWER INPUT Switch	NORMAL
DROP OUT/NORMAL Switch	NORMAL
SOURCE Switch	NORMAL
AUX INITIATE Switch	NORMAL
AUX ADJUST Control Knob	"0"
NORMAL/DROPOUT	NORMAL
NORMAL/BYPASS	NORMAL

TESTING PICKUP

1. Connect the operating coil and one restraint coil of the relay to the 0-10V/140A terminal and the (±) COMMON.

2. Connect light leads from binding posts marked Stop/Monitor to Trip circuit terminals of the relay.

   NOTE: These type relays usually have one moving contact and two fixed contacts. Use binding post terminals for one moving contact and one of the fixed contacts.

3. Set AC AMMETER RANGE Switch so that expected pickup current will be read in upper 1/3 of the ammeter scale.

4. Initiate test set by pressing INITIATE Switch.

5. Rotate AC CONTROL Knob to increase output until relay picks up and CONTINUITY light glows or the TONE generator sounds. The Vernier control knob may be used for fine adjustment. Read and record current.

6. Move one light lead to relay terminal for pickup of the other fixed contact of the relay and repeat test.

7. Return controls to "0" position and de-initiate test set.

TESTING TIME CURRENT CHARACTERISTICS

1. Set AC AMMETER RANGE Switch so that the desired test current can be read in upper 1/3 of the meter scale. Set CURRENT MEMORY/CONTINUOUS Switch to MEMORY.

2. Set INITIATE CONTROL knob to MOM.

3. Set test current by "jogging" with the INITIATE Switch and rotating the AC Current Control Knob of Unit #1 to increase the output until the ammeter indicates the desired test current.

4. Set INITIATE CONTROL to MAINT. and the TIMER CONTROL to the INITIATE position.

5. Reset TIMER by pressing the RESET button.

6. Initiate the test set by pressing the INITIATE Switch. The unit will energize and the Timer will begin to run. When the relay contacts close, the Timer will stop and the unit will de-energize itself.

7. Read and record time indicated on the Timer.

8. Return all controls to zero and de-initiate test set.

TESTING THROUGH FAULT

1. Connect the 0-25A binding posts of Unit #2 to the restraint current coil terminals of the relay, by a series connection of the restraint current coils. Observe polarity.

2. Select the proper ammeter range.

3. Set the INITIATE CONTROL MAINT. and the TIMER CONTROL to the INITIATE position.

4. Switch POWER ON/OFF Switch ON.

5. Initiate unit by pressing INITIATE Switch.

6. Rotate the AC ADJUST Control knob to increase output to desired value. Read current on ammeter.

7. Manually "turn" relay disc for evidence of restraint current.

8. Return control knob to zero and de-initiate test set.

TESTING SLOPE

1. Connect the operating coil and one restraint coil to the 17.5A output terminals of Unit #1. Observe polarity.

2. Select the proper ammeter ranges for both AC Ammeters.

3. Connect light leads from the binding posts marked STOP/MONITOR to the trip circuit terminals of the relay.

4. Set INITIATE CONTROL to MAINT.

5. Initiate the test set by pressing the INITIATE Switch.

6. Rotate the AC ADJUST Control knob of Unit #2 until the restraining current is obtained.

7. Rotate the AC CONTROL knob of Unit #1 until the CONTINUITY light flickers, or the HORN sounds. The slope of the relay is determined by dividing the operating current by the restraint current.

8. If desired, the test may be repeated for the opposite restraint coil by disconnecting test leads from the operating coil terminal and re-connecting test leads to opposite restraint coil terminal and operating coil terminal.

9. After test is completed, turn all controls to "0" and switch the POWER ON/OFF Switch OFF.

TRANSFORMER DIFFERENTIAL RELAY WITH PERCENTAGE AND HARMONIC RESTRAINT
General Electric Type BDD

GENERAL

The Type BDD relay is a single-phase transformer differential relay provided with the features of percentage and harmonic restraint and has a sensitive polarized relay as the operating element. Percentage restraint permits accurate determination between internal and external faults at high currents. Harmonic restraint enables the relay to distinguish, by the difference in waveform, between the differential current caused by an internal fault and that caused by transformer magnetizing inrush.

The harmonic restraint and slope tests are written based on testing the relay with all restraint windings set in the 5A tap. If the relay is to be tested with any other tap settings, please refer to the G.E. instruction book under "Periodic Testing".

The Type BDD 15 relay is designed to be used for the protection of two-winding power transformers and has two (2) through-current restraint circuits and one (1) differential current circuit.

The Type BDD 16 relay is designed to be used with three-winding power transformers and has three (3) through-current restraint circuits and one (1) differential current circuit.

TYPES OF TESTS

Pickup of DHR Unit
Slope
Harmonic Restraint
Pickup of Instantaneous Unit

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
HORN/MONITOR Switch	Either position
INITIATE CONTROL	MAINT.
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	So that the desired AC current can be read in upper 1/3 meter scale

DC/OFF/VERNIER Switch	VERNIER
DC OR AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/0-300V/0-600V AC Switch	0-25A
AC AMMETER RANGE Switch	25A
AC ADJUST Control Knob	"0"
HARMONIC RESTRAINT/NORMAL Switch	NORMAL
AC INITIATE Switch	NORMAL
AUX ADJUST Control Knob	"0"
AUX VOLTAGE Section	DC/150V
AUX VOLTMETER	DC
AUX INITIATE Switch	NORMAL
AUX VOLTMETER Selector Switch	200V
DROPOUT/NORMAL Switch	NORMAL
SOURCE Switch	NORMAL

INITIAL TEST CONNECTIONS

1. a. 8.75A binding post on Unit #1 to terminal 5 of the relay.

   b. 0-25A COMMON (±) binding post on Unit #2 to COMMON (±) binding post on Unit #1.

   c. COMMON (±) binding post on Unit #1 to terminal 4 of the relay.

   d. AUX DC VOLTAGE OUTPUT Binding Posts, of Unit #2, to terminal 1 and 7 of the relay. Red (+) to terminal 1.

   e. STOP/MONITOR Binding Posts to terminals 1 and 2 of the relay.

2. Reset TIMER by pressing the RESET Pushbutton.

3. Initiate unit by depressing INITIATE Pushbutton.

4. Rotate AUX ADJUST Control Knob, of Unit #2, clockwise until rated DC voltage is indicated on the AUX DC Voltmeter.

   NOTE: For the duration of the test, rated voltage will be present on the relay, whenever the test set is INITIATED.

TESTING PICKUP

5. Rotate AC CONTROL Knob of Unit #1 in a clockwise direction until an indication of pickup is detected by the CONTINUITY Lamp or TONE Generator. Read and record the value of pickup current observed on the AC AMMETER on Unit #1.

6. Return the AC Control Knob to "0".

7. Observe that the target element (T) "dropped" during the test.

8. Move test lead connected to COMMON (±) from terminal 4 to terminal 6 of the relay.

9. Rotate AC CONTROL Knob in a clockwise direction until an indication of pickup is detected by the CONTINUITY Lamp or TONE Generator. Read and record the value of pickup current observed on the AC AMMETER on Unit #1.

10. Return AC Control Knob to "0" and de-initiate test set.

TESTING SLOPE

11. Connect 0-25A current output Binding Post of Unit #2 to terminal 4 of the relay.

12. Place INITIATE CONTROL in the MOM. position.

WARNING

The relay coils are energized as long as the test set is initiated. Therefore, this test should be conducted as rapidly as possible to prevent damage to relay coils.

13. Preset and hold INITIATE Pushbutton, rotate AC ADJUST Control Knob until an indication of 20 amperes is observed on the AC AMMETER of Unit #2. Release INITIATE Pushbutton. Reset INITIATE CONTROL to the MAINT. position.

14. Set AC AMMETER Range Switch on Unit #1 to 20A position.

15. Set CURRENT/MEMORY Switch to MEMORY.

16. INITIATE test set and slowly rotate AC CONTROL Knob until pickup is detected by the AC CURRENT MEMORY circuit. Read value of current indicated on AC AMMETER on Unit #1.

17. Record value of current read in step 16.

18. Return AC ADJUST Control Knob to "0".

19. Return AC CONTROL Knob to "0" and de-initiate test set.

TESTING HARMONIC RESTRAINT

20. Place INITIATE CONTROL in the MAINT. position.

21. Place AC AMMETER Range Switch on Unit #2 in the 25A position.

22. Place DC AMMETER Range Switch on Unit #1 in the 5A position.

23. Place the HARMONIC RESTRAINT Switch in the HARMONIC RESTRAINT position.

24. Move the test lead from the 0-25A output (blue) binding posts from terminal 4 of the relay to terminal 5 of the relay.

25. Initiate test set by pressing INITIATE Pushbutton.

26. Rotate AC ADJUST Control Knob of Unit #2 clockwise until an indication of 4 amperes DC is observed on the DC AMMETER on Unit #1.

27. Rotate AC CONTROL Knob until pickup is detected by the CONTINUITY Lamp or TONE Generator. Read and record the value of current indicated by the AC AMMETER on Unit #1.

    NOTE: **While adjusting the AC CONTROL Knob of Unit #1, make necessary adjustments using AC ADJUST Control Knob of Unit #2 to maintain 4 amperes DC on the DC ammeter of Unit #1.**

28. Return the AC CONTROL Knob to "0".

29. Return the AC ADJUST Control Knob to "0".

30. Return DC VERNIER Control Knob to "0".

TESTING INSTANTANEOUS UNIT

31. Set INITIATE CONTROL in the MOM. position.

32. Disconnect test lead of Unit #2 0-25A output (blue) binding post from the relay.

33. Set AC AMMETER RANGE Switch on Unit #1 to 200A position.

34. Connect test leads from Unit #1 to terminals 5 and 6 of the relay.

35. Initiate unit by holding in INITIATE Pushbutton.

NOTE: Steps 35 and 36 should be performed as quickly as possible to avoid relay damage. The preferred method is to reference back to the AC CURRENT MEMORY/CONTINUOUS FUNCTION OF UNIT #1.

36. Rotate AC CONTROL Knob clockwise to increase current until pickup is detected by the CONTINUITY Lamp or TONE Generator.

37. Read the value of current on the AC AMMETER on Unit #1 and release the INITIATE Pushbutton.

38. Record value of current observed in Step 37.

39. De-initiate test set and remove all test leads.

TYPICAL TEST FOR DC AUXILIARY RELAYS

TYPES OF TESTS
Pickup
Dropout
Timing Dropout

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
HORN/MONITOR Switch	Either position
INITIATE CONTROL	MAINT.
TIMER CONTROL	INITIATE
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	20A
DC/VERNIER Selector Switch	OFF
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/0-300V/0-600V Switch	0-25A
AC INITIATE Switch	NORMAL
AC ADJUST Control Knob	"0"
VOLTMETER RANGE Switch	So that the desired test current can be read in UPPER 1/3 of scale
HARMONIC RESTRAINT/NORMAL Switch	NORMAL
SOURCE Switch	NORMAL

NORMAL/DROP OUT Switch	NORMAL
AUX INITIATE Switch	NORMAL
AUX VOLTAGE SELECTOR Switch	DC; Either 150V or 300V
AUX VOLTMETER SELECTOR Switch	DC; Either 200V or 500V
AUX ADJUST Control Knob	"0"

TESTING PICKUP

1. Connect the operating coil terminals of the relay to the AUX AC/DC OUTPUT Red (+) and Black (-) binding posts of the AUX OUTPUT section of Unit #2.

2. Connect light leads from binding posts marked STOP/MONITOR, of Unit #1, to trip circuit contact terminals of the relay.

3. Initiate unit by pressing INITIATE Switch.

4. Rotate AUX ADJUST Control knob clockwise to increase output until CONTINUITY light flickers or TONE generator sounds.

5. Read pickup voltage on voltmeter. Record.

6. Rotate AUX ADJUST Control knob counterclockwise to decrease output until CONTINUITY light extinguishes or output from TONE generator breaks.

7. Read dropout voltage on voltmeter. Record.

TESTING DROPOUT TIME

8. Set INITIATE CONTROL to MAINT. and TIMER CONTROL to V.RLY/DO. Set STOP GATE to N.C. DRY CONTACTS.

9. Rotate AUX ADJUST Control Knob clockwise until rated voltage is applied to relay.

10. Manually close the relay trip circuit contacts so that the DC contacts will pickup and seal-in. Release the relay trip contacts. The DC contacts should stay sealed in.

11. RESET digital timer.

12. Switch NORM/DROPOUT Switch to the DROPOUT position. The DC voltage is switched OFF and the TIMER is automatically initiated. When the DC contacts dropout, the timer will stop. Read and record this value.

13. Return AUX ADJUST Control Knob to "0" position and switch POWER OFF.

TESTING INSULATION RESISTANCE

NOTE: NEVER PERFORM AN INSULATION RESISTANCE TEST ON A SOLID STATE OR STATIC RELAY.

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
AUX INITIATE Switch	Center Pos.
0-25A/0-300V/0-600V Output Select Switch	0-300V AC
AC AMMETER RANGE Switch	25A
AC INITIATE Switch	NORMAL
AC ADJUST Control Knob	"0"
HARMONIC RESTRAINT/NORMAL Switch	NORMAL
SOURCE SELECTOR Switch	NORMAL
AUX VOLTAGE RANGE SELECTOR Switch	500V
AUX ADJUST Control Knob	"0"
AUX IR TEST Switch	OFF
NORMAL/DROPOUT Switch	NORMAL

TESTING

1. Connect Model SR-90 to a suitable source of power. Be sure the AUX INITIATE Switch is OFF, in the center position.

2. Switch the AUX INITIATE to BYPASS, turning Unit #2 test set ON.

3. Set AUX VOLTAGE Switch to IR.

4. Initiate IR TEST by depressing INITIATE Switch of IR TEST. The insulation resistance test circuit light, ON/SET, should glow.

5. Rotate AUX ADJUST Control Knob to increase output to 500 volts DC, as indicated on the AUX DC VOLTMETER.

6. Set AUX VOLTMETER RANGE SELECTOR Switch to the Megohm range as indicated by the symbol M(Ω).

7. Connect high voltage test probes to the output terminals and to the relay under test. The relay components will not be harmed as long as one probe is applied to relay frame and the other to all external terminals of the relay.

8. Switch IR TEST Switch to TEST position. 500 volts DC is now applied to the relay and the insulation resistance can be read on the megohm scale of the voltmeter.

9. Return AUX ADJUST Control knob to "0" and switch, main power, AUX INITIATE to center position OFF.

TESTING I.T.E. CIRCUIT SHIELD
SOLID-STATE OVERCURRENT RELAYS

The following procedure outlines the most efficient manner to consecutively perform all tests on an I.T.E. solid state overcurrent relay. This procedure involves the least possible number of changes in the connecting of test leads and setting of test controls.

TYPES OF TESTS

Pickup - Timing Circuit
Time Delay Test
Instantaneous Pickup Test
DC Target - Timing Circuit
DC Target - Instantaneous Circuit

CAUTION

NEVER FEED VOLTAGE INTO THE N.O. or N.C. DRY CONTACT CIRCUIT MODEL SR-90. ALWAYS USE THE VOLTAGE APPLIED CONTACT MONITOR CIRCUIT OF THE MODEL SR-90. OTHERWISE DAMAGE WILL OCCUR TO THE SOLID-STATE COMPONENTS OF THE SR-90 AS WELL AS TO THE RELAY.

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MOM.
TIMER CONTROL	INITIATE
MONITOR/HORN Switch	Either position
DC VOLTMETER RANGE Switch	150V
DC or VERNIER Control Knob	"0"
AC AMMETER RANGE Switch	To read test current in the upper 1/3 of meter scale.
AC CONTROL Knob	"0"
DC or VERNIER/Switch	DC

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/0-300V/0-600V AC Switch	300V AC
0-25A or 0-300V AC ADJUST Knob	"0"
VOLTMETER RANGE Switch	150V

PICKUP- TIMING CIRCUIT

1. Connect relay input circuit (relay terminals 1-2, 3-4, or 5-6) to the binding posts of Unit #1. It is recommended that the (0-80V) @ 17.5A output tap be used and for the 0.5 to 2.0 amp relays, it is recommended to use the (0-160V) @ 8.75A output tap.

2. Connect a pair of light leads from the binding posts marked STOP/MONITOR to terminals 8 and 12. Select the STOP GATE for VOLTAGE APPLIED mode of operation.

3. Select the AC AMMETER RANGE Switch so that the relay's tap value of current may be read on the upper 1/3 of the ammeter scale.

4. Connect a pair of leads from the Red and Black binding posts of the DC OUTPUT Section, of Unit #1, to terminals 7 and 8 with Black (±) post to terminal 8. Select the required DC VOLTAGE RANGE of either 150V or 300V.

5. INITIATE the test set by pressing and holding the INITIATE pushbutton.

6. Rotate DC VERNIER knob, on Unit #1, until rated DC logic voltage is read on the voltmeter.

7. Rotate AC CONTROL knob to increase output until test current on relay is (-5%) of tap value.

8. Release the INITIATE pushbutton, de-energizing the test set.

9. Set INITIATE CONTROL to MAINT. and reset TIMER. Initiate test set by pressing INITIATE Switch. Relay input circuit will "see" test current. Relay <u>should not</u> operate. De-energize the test.

10. Repeat Steps 5 through 9 above, except test current should be set at relay tap value (+5%).

11. Initiate test set by pressing INITIATE Switch. Relay input circuit will "see" test current. Relay <u>should</u> operate.

TIME DELAY AND TARGET TEST

1. Set INITIATE CONTROL to MOM.

2. Select AC AMMETER/VOLTAGE RANGE Switch so that desired test current may be read on the upper 1/3 or ammeter scale.

3. Set the AC CURRENT SELECTOR to MEMORY and to the desired test current.

4. Increase test current by "jogging unit" with INITIATE Switch and rotating AC CONTROL knob to increase output until desired test current is indicated by the ammeter. Release INITIATE Switch.

5. Set INITIATE CONTROL to MAINT and reset timer by pressing the reset buttom.

6. Initiate unit by pressing INITIATE Switch. TIMER will initiate and test current will be indicated on ammeter. The test set will automatically de-initiate and the TIMER will stop when relay's contacts close. Relay target should operate.

INSTANTANEOUS PICKUP AND TARGET TEST

1. Set INITIATE CONTROL to MOM.

2. Relay terminal connections will be the same as for the above tests except jumper terminals 9 and 10.

3. Select an AC AMMETER RANGE so that desired test current may be read on the upper 1/3 of ammeter scale.

4. Initiate unit by pressing and holding INITIATE Switch. Rotate AC CONTROL Knob to increase current output until test current on relay is (-10%) of instantaneous setting. [For 0.5 to 2.0 ampere tap range, the setting should be (-20%)].

5. Release INITIATE Switch. Reset TIMER.

6. Press and hold INITIATE Switch. Relay instantaneous circuit **should-not** pickup to stop timer (allow approximately 0.30 seconds).

7. Repeat Step 4, except test current should be (+10%) of relay instantaneous setting. [For 0.5 to 2.0 ampere tap range, the settings should be (+20%)].

8. Press and hold INITIATE Switch. Relay instantaneous circuit should pick-up and stop the timer. Relay target should operate.

9. Release INITIATE Switch.

WARNING

CURRENT INDICATED ON AMMETER IS PRESENT IN RELAY CIRCUIT UNTIL INITIATE SWITCH IS RELEASED: THEREFORE, IT IS IMPORTANT TO PERFORM THIS TEST AS RAPIDLY AS POSSIBLE TO AVOID OVERHEATING RELAY.

10. Turn POWER ON/OFF Switch OFF.

DIRECTIONAL OVERCURRENT RELAY
Westinghouse Type CR
General Electric Type IBC

GENERAL

A Directional Overcurrent Relay trips a circuit when it senses two abnormal conditions in the following sequence:

1. Current flow must be reversed.

2. The reversed current flow must be higher than a prescribed amount, and the flow must continue for a predetermined time.

This relay is composed of two units, a directional unit and an overcurrent unit. The directional unit is similar to a single phase wattmeter. It contains a voltage actuated and current actuated coil. When these two coils are energized, a torque is produced on the unit's disc. A 180° shift in phase relationship between the voltage and current produces a reverse torque on the disc. Normally, the torque produced holds the directional unit contacts open. When the current flow in the circuit reverses, the directional unit contact will close.

The overcurrent unit of the relay is similar to the time delay overcurrent relay. In modern designs, the directional unit contacts must be closed before operating torque will be produced on the induction disc of the overcurrent unit. Thus, the directional overcurrent relay requires reversal as well as a minimum quantity of current flow before it may operate to trip a breaker.

The test procedure is arranged to test each element of the relay individually. The directional element contacts must be blocked, closed, or bypassed to permit complete testing of the overcurrent element.

TYPES OF TESTS

Directional Unit - Minimum Pickup
Overcurrent Unit
1. Minimum pickup
2. Time current characteristics

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.

HORN/MONITOR Switch	Either position
AC Control Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	200A
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/300V/0-600V Output Select Switch	0-25A
AC AMMETER RANGE Switch	25A
AC ADJUST Knob	"0"
VOLTMETER RANGE Switch	1.5V
AC INITIATE Switch	NORMAL
AUXILIARY Adjust Control Knob	"0"
AUX. INITIATE Switch	NORM.
D.E.T. Switch	RATED setting per manual instruction leaflet
NORMAL/DROPOUT Switch	NORMAL

DIRECTIONAL UNIT MINIMUM PICKUP

1. Connect polarity terminal (±) of relay directional unit's current operating coil to the polarity terminal (Black ±) of the AC/DC OUTPUT section of Unit #2. The other relay current operating coil terminal should be connected to the (Blue) binding post of the 0-25A section of Unit #2.

2. Connect the polarity (±) terminal of the relay voltage polarity coil to the (Red) binding post of the AC/DC OUTPUT section of Unit #2.

3. Place a jumper from the non-polarity terminal of the voltage polarizing coil to the polarity (±) terminal of the current polarizing coil on the relay.

4. Switch D.E.T. selector switch to desired test position.

5. Reset the TIMER and initiate the test set by pressing the INITIATE Button.

6. Rotate AC ADJUST Control knob of Unit #2 clockwise to increase output until directional unit contacts close. Reduce output just until the contacts start to open. Read and record values.

   NOTE: CURRENT AMPLITUDE will be displayed on ammeter and VOLTAGE Amplitude will be displayed on AUX. VOLTMETER.

7. Reverse leads from test set to simulate 180 degree phase shift. Relay directional unit contacts should resist contact closure.

TESTING PICKUP AND TIMING OF OVERCURRENT UNIT

1. Block directional unit contacts closed and follow procedure for Induction Disk Overcurrent Relay.

NOTE: AT END OF TEST REMOVE ALL BLOCKING MATERIAL

VOLTAGE RESTRAINT OVERCURRENT RELAY
General Electric Type IJCV

GENERAL

The IJCV contains an induction disc which is influenced by the magnetic fields of two electromagnets. The current actuated electromagnet produces torque on the disc *to close* the relay trip circuit contacts and is known as the operating coil. The potential actuated electromagnet produces torque on the disc *to open* the relay trip circuit contacts and is known as the restraint coil. When the voltage applied to the restraint coil is decreased, a smaller amount of current is required to operate the relay and close the trip circuit contacts. This relay may operate to close trip circuit contacts even though the voltage applied to the restraint coil may remain at full system voltage.

The IFCV relay is normally used to protect a generator against bus faults.

TYPES OF TESTS

Pickup of Overcurrent Unit, Zero Voltage Restraint
Pickup of Overcurrent Unit, System Voltage Restraint
Timing of Overcurrent Unit, Zero Voltage Restraint
Timing of Overcurrent Unit, System Voltage Restraint

ALWAYS REFER TO MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	So that desired test current may be read on upper 1/3 of meter scale
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

TESTING FOR PICKUP - ZERO VOLTAGE RESTRAINT

1. Connect the relay voltage restraint coil terminals to the Red and Black binding posts, labeled AC/DC OUTPUT on unit #2.

2. Connect the relay current operating coil terminals to Unit #1, 17.5A output terminal and the return to COMMON (±).

3. Connect a set of light leads from the relay trip circuit contact terminals to the test set's STOP/MONITOR binding posts.

4. INITIATE Unit by pressing INITIATE Switch.

5. Increase current through the current operating coil of relay to a value 50% above relay trip setting by rotating AC CONTROL knob clockwise.

6. When relay contacts close, CONTINUITY light should glow or TONE Generator should sound.

7. Slowly decrease current by rotating the AC CONTROL knob counterclockwise until CONTINUITY light flickers, or TONE breaks. Record this value of current as "Pickup - Zero Voltage Restraint".

8. Return AC CONTROL knob to "0" and de-initiate test set.

TESTING FOR PICKUP - SYSTEM VOLTAGE RESTRAINT

1. Repeat Steps 1 through 4 for TESTING FOR PICKUP - ZERO VOLTAGE RESTRAINT.

2. Apply system voltage to voltage restraint coil of relay by rotating the AUX ADJUST Control Knob (clockwise).

3. Repeat steps 5 through 8 for TESTING FOR PICKUP - ZERO VOLTAGE RESTRAINT and record "Pickup - System Voltage Restraint".

TESTING TIMING - OVERCURRENT UNIT - ZERO VOLTAGE RESTRAINT

1. Connect the relay voltage restraint coil terminals to the Red and Black binding posts, labled AC/DC OUTPUT on unit #2.

2. Connect the relay current operating coil terminals to Unit #1, 17.5A output terminal and the return to COMMON (±).

3. Connect a set of light leads from the relay trip circuit contact terminals to the test set's STOP/MONITOR binding post.

4. Set INITIATE CONTROL to MOM.

5. Preset AMMETER to MEMORY position and set the desired test current.

6. De-initiate the test set by releasing the initiate button. Reset timer.

7. Set initiate control to maint.

8. Initiate unit by pressing INITIATE SWITCH. TIMER will initiate and test current will flow until the relay trip circuit contacts close.

9. Read TIMER and record time. Time shown is total time of test.

TESTING TIMING - OVERCURRENT UNIT - SYSTEM VOLTAGE RESTRAINT

1. Repeat Steps 1 through 6 for TESTING TIMING - OVERCURRENT UNIT - ZERO VOLTAGE RESTRAINT.

2. Rotate AUX ADJUST Control Knob (clockwise) to increase voltage until equal to relay system voltage.

3. Initiate unit by pressing INITIATE SWITCH. TIMER will initiate and test current will flow until the relay trip circuit contacts close.

4. Record time shown as "Overcurrent Timing Test with System Voltage Applied".

VOLTAGE CONTROLLED OVERCURRENT RELAY
Westinghouse Type COV

GENERAL

The COV relay contains an induction disc overcurrent unit and instantaneous undervoltage unit. The undervoltage unit supervises the operation of the overcurrent unit. Regardless of the amount of current passing through the operating coil of the overcurrent unit, no operation takes place unless the undervoltage unit has "dropped out". This means that the overcurrent unit may be set to operate on less than full load current when the voltage falls below a predetermined value. Conversely, the overcurrent unit will not operate as long as the voltage is above the predetermined value.

This relay is normally used to protect a generator against a bus fault.

TYPES OF TESTS

Pickup - Undervoltage Unit
Dropout - Undervoltage Unit
Voltage Control of Overcurrent Unit
Pickup - Overcurrent Unit
Time Current Characteristics - Overcurrent Unit

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC or VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	Desired Position
DC or VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
VOLTMETER RANGE Switch	So that the desired test voltage will be read in upper 1/3 of scale
SOURCE Switch	NORMAL
VOLTMETER CIRCUIT SELECTOR Switch	AC
AUXILIARY OUTPUT Control Knob	"0"
VOLTAGE OUTPUT Selector Switch	150V AC or 300V AC (depending on nominal operating voltage of the relay)
NORMAL/DROPOUT Switch	NORMAL
AUX INITIATE Switch	NORMAL

TESTING PICKUP AND DROPOUT OF UNDERVOLTAGE UNIT

1. Connect the Red and Black binding posts of Unit #2, AC/DC OUTPUT, to the undervoltage unit operating coil terminals.

2. Connect a pair of light leads from the STOP/MONITOR binding posts of the test set to the relay undervoltage unit contact terminals.

3. Initiate the test set by pressing the INITIATE CONTROL Switch.

4. Rotate the AUX ADJUST Control knob (clockwise) to increase voltage applied to the undervoltage unit operating coil until the continuity light just goes out. Read and record this value of voltage as the pick-up voltage of the undervoltage unit.

5. Continue to rotate AUX ADJUST Control knob clockwise to increase applied voltage until relay rated voltage is read on the test set voltmeter.

6. Rotate the AUX ADJUST Control knob counterclockwise to decrease applied voltage until the Continuity light first lights. Read and record this voltage value as the drop out voltage of the undervoltage unit.

7. Return AUX OUTPUT Control knob to "0" and de-initiate the test set.

TESTING VOLTAGE CONTROL OF OVERCURRENT RELAY

1. Connect the Unit #2, AC/DC OUTPUT, Red and Black binding posts to the undervoltage unit operating coil terminals.

2. Connect the AC Current output terminals of Unit #1 to the overcurrent operation coil terminals.

3. Adjust the AC AMMETER Range Switch so that the desired test current may be read on the upper 1/3 of the meter scale.

4. Connect a set of light leads from the STOP/MONITOR binding posts to the relay trip circuit contact terminals.

5. Press the timer reset button and initiate the test set by pressing the INITIATE CONTROL Switch.

6. Rotate AUX ADJUST Control knob clockwise until relay rated voltage is read on the voltmeter.

7. Rotate the AC CONTROL Knob clockwise until the value of current read on the AC AMMETER is approximately four times tap value of the overcurrent unit.

8. The overcurrent unit ***should not operate*** to close the relay trip circuit contacts.

9. Rotate the AUX ADJUST Control knob counterclockwise to ***reduce*** the voltage until the undervoltage unit drops out.

10. The overcurrent unit should operate to close the relay trip circuit contacts. This will stop the timer and de-energize the test set. There is no need to record the time indicated on the TIMER, this not the timing set.

TESTING PICKUP AND TIMING OF THE OVERCURRENT UNIT

1. Insure that the undervoltage contacts are closed before conducting tests.

2. Follow the test procedures for testing an overcurrent relay.

TRANSFORMER DIFFERENTIAL RELAY WITH PERCENTAGE AND HARMONIC RESTRAINT
Westinghouse Type HU

GENERAL

The Type HU relay is a single-phase transformer differential relay provided with the features of percentage and harmonic restraint and has a sensitive polarized relay as the operating element. Percentage restraint permits accurate determination between internal and external faults at high currents Harmonic restraint enables the relay to distinguish, by the differences in waveform, between the differential current caused by an internal fault and that caused by transformer magnetizing inrush.

The Type HU relay is designed to be used for the protection of two-winding power transformers and has two (2) through-current restraint circuits with one (1) deferential current circuit.

The Type of HU-1 relay is designed to be used with three-winding power transformers and has three (3) through-current restraint circuits and one (1) differential current circuit.

TYPE OF TESTS

Pickup
DC Target
Slope
Harmonic Restraint
Instantaneous Unit

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either Position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	20A
DC or AC VERNIER Control Knob	"0"

SET-UP OF CONTROLS ON UNIT #2

HARMONIC RESTRAINT/NORMAL Switch	NORMAL
OUTPUT SELECT Switch	0-25A
AC AMMETER RANGE Switch	25A
AC ADJUST Knob	"0"
AC INITIATE Switch	NORMAL
VOLTAGE SELECTOR Switch	DC/150 V
AUX ADJUST Control Knob	"0"
NORMAL/DROPOUT Switch	NORMAL
AUX INITIATE Switch	NORMAL

INITIAL TEST CONNECTIONS

1. a. 8.75A current output binding post on Unit #1 to terminal 3 of the relay.

   b. COMMON (±) binding post on Unit #1 to the 0-25A COMMON (±) binding post on Unit #2.

   c. COMMON (±) binding post on Unit #1 to terminal 7 of the relay.

   d. 0-25A (Blue) binding post on Unit #2 to terminal 5 of the relay.

   e. STOP/MONITOR binding posts to terminals 1 and 10 of the relay.

TESTING PICKUP

2. Block relay contact on the harmonic restraint unit closed.

4. Reset TIMER by pressing RESET Pushbutton.

5. Initiate unit by pressing INITIATE Pushbutton.

6. Rotate AC CONTROL Knob in a clockwise direction until an indication of pickup is detected by the CONTINUITY Lamp or TONE Generator. Read and record the value or pickup current observed on the AC AMMETER of Unit #1.

7. Return AC CONTROL Knob to "0" and de-initiate test set.

TESTING DC TARGET AND SEAL-IN

8. Place DC/OFF/VERNIER Switch to the DC Position.

9. Rotate AC CONTROL Knob in a clockwise direction until an indication on the AC AMMETER on Unit #1 of the value recorded for pickup plus 0.5 amperes is obtained.

10. Rotate DC Vernier Knob in a clockwise direction until the Target and Seal-In unit operates and the target "drops". Read and record value of current observed on DC AMMETER.

11. Return AC CONTROL Knob to "0". Observe DC AMMETER to verify that DC current continues to flow, through the DC target and seal-in coil.

12. Reduce the DC Vernier Knob until a drop out value is indicated by the releasing of the DC seal-in coil. Record this value.

13. De-initiate test set.

TESTING SLOPE

14. INITIATE UNIT by pressing INITIATE Pushbutton.

15. Set AC AMMETER Range Switch on Unit #2 to 25A position.

16. Rotate AC ADJUST Knob until 10 amperes AC is indicated by the AC AMMETER on Unit #2.

17. Set CURRENT MEMORY/CONTINUOUS switch on Unit #1 to MEMORY.

18. Slowly rotate AC CONTROL Knob of Unit #1 until pickup is indicated by the de-initiation of the test set through the CURRENT MEMORY control circuitry or by the CONTINUITY Lamp or TONE Generator. Read and record this value.

19. Return AC ADJUST Knob to "0".

20. Return AC CONTROL Knob to "0" and de-initiate test set.

TESTING HARMONIC RESTRAINT

21. Remove blocking on harmonic restraint unit and block differential unit contacts closed.

22. Place the HARMONIC RESTRAINT Switch in the HARMONIC RESTRAINT position. Connect the 0-25A (Blue) binding post on Unit #2 to terminal 3 of the relay.

23. This step is no longer needed, proceed to Step 24.

24. Set AC AMMETER RANGE Switch on Unit #1 to the 20A position.

25. Set AC AMMETER RANGE Switch on Unit #2 to the 25A position.

26. Rotate AC ADJUST Control Knob clockwise until an indication of 4 amperes DC is observed on the DC AMMETER in the Unit #1.

27. Rotate AC CONTROL Knob until pickup is detected by the CONTINUITY Lamp or TONE Generator. Read and record the value of current indicated by the AC AMMETER on Unit #1.

    NOTE: While adjusting the AC CONTROL Knob, make necessary adjustments using AC ADJUST Control Knob to maintain 4 amperes DC on the DC AMMETER.

28. Return the AC CONTROL Knob to"0".

29. Return the AC ADJUST Knob to "0" and de-initiate the test set.

TESTING INSTANTANEOUS UNIT

30. Place INITIATE CONTROL in the MOM. Position.

31. Set AC AMMETER RANGE Switch on UNIT #1 to the 200A position.

32. Connect test leads of Unit #1 to terminals 3 and 5 of the relay.

33. Disconnect the test leads from Unit #2.

34. Block harmonic and differential units *open*.

35. Initiate unit by *holding in* INITIATE Pushbutton.

36. Rotate AC CONTROL Knob clockwise to increase current until pickup is detected by the CONTINUITY Lamp or TONE Generator.

37. Read value of current on AC AMMETER and release INITIATE Pushbutton.

38. Record value of current on AC AMMETER.

39. De-initiate test set and remove all blocking from the relay.

CURRENT PHASE BALANCE RELAYS
Westinghouse Type CM
General Electric Type IJC

GENERAL

The Current Phase Balance Relay operates to trip a circuit breaker when the phase currents in a circuit become unbalanced by some predetermined amount. This relay compares the three phase currents of a line.

GENERAL ELECTRIC TYPE IJC

The General Electric IJC relay is composed of three individual induction discs with two coils per disc. One coil produces a contact closing torque on the disc and is called an operating coil. The second coil produces a contact opening torque on the disc and is called a restraint coil. These two coils see currents from different phases of the circuit and the relay will operate when the phase currents become sufficiently unbalanced. The trip circuit contacts associated with all three induction discs are connected in parallel.

TYPES OF TESTS

Pickup
Timing
Slope
Target and Seal-In

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	Set to read test current in upper section of meter scale.
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
OUTPUT SELECT AC Switch	0-25A
AC AMMETER RANGE Switch	25A
AC ADJUST CONTROL Knob	"0"
AC INITIATE Switch	NORMAL
VOLTAGE SELECTOR Switch	AC; 150V
AUX ADJUST Control Knob	"0"
NORMAL/DROPOUT Switch	NORMAL
AUX INITIATE Switch	NORMAL

TESTING PICKUP

1. Connect one current operating coil of the relay to the 8.75A terminal and the COMMON (±). Observe polarity.

2. Initiate test set by depressing the INITIATE Switch.

3. Slowly increase current by rotating AC CONTROL Knob and VERNIER Control Knob clockwise until relay disc moves and contacts are closed. Then decrease current until disc remains stationary.

4. Record this value of current as the pickup value.

5. Repeat for operating coils of the other two relay current operating coils.

6. Return Control Knobs to the "0" position and de-initiate test set.

TESTING TIMING

1. Set AC AMMETER RANGE Switch so that the desired test current can be read in upper 1/3 of the meter scale.

2. Set INITIATE CONTROL to MOM. and CURRENT MODE Switch from CONTINUOUS to MEMORY.

3. Set test current by "jogging" the INITIATE Switch and rotating the AC CONTROL Knob to increase the output until the ammeter registers the desired test current.

4. Set INITIATE CONTROL to the MAINT. position.

5. Using a pair of light leads, connect the relay trip circuit contact terminals to the STOP/MONITOR binding posts on Unit #1.

6. Reset TIMER by depressing the RESET button.

7. Initiate the test set by depressing the INITIATE Switch. The TIMER will initiate and when the relay contacts close, the TIMER will stop and de-energize the test set.

8. Read and record time indicated on the TIMER.

9. Repeat Steps 1 through 8 for operating coils of the other two relay coils.

TESTING SLOPE

1. Connect restraint coil to the 0-25A terminals, observing polarity.

2. Select the proper ammeter ranges for both Unit #1 and #2 AC Ammeters.

3. Set INITIATE CONTROL to MAINT.

4. Initiate the test set by pressing the INITIATE Switch.

5. Rotate AC ADJUST Control Knob clockwise to energize the restraint coil of relay unit under test.

6. Rotate AC CONTROL Knob clockwise to energize the operating coil of relay unit under test.

7. Regulate the two currents until the disc of the relay under test is stopped with that unit's trip circuit contacts. (About halfway between full open position and trip position.)

8. Record both values of current and calculate slope.

9. Repeat Steps 1 through 8 for the other relay units.

WESTINGHOUSE TYPE CM RELAY

The Westinghouse Type CM relay has two individual induction discs. Each disc has two current coils. One coil produces torque to move the disc to the left and the other coil produces torque to move the disc to the right. As long as the currents energizing the two coils are equal, the torques cancel and the disc remains stationary. In connecting the relay in the circuit, the coil production rotation to the right on one disc is in "A" Phase, while the coil producing rotation to the left on the same disc is in "B" Phase. Each unit of the relay has a moving contact attached to the disc shaft and two stationary contacts, one on the right and one on the left. When the relay is energized with balanced 3-phase currents, the moving contacts of both relay units should be midway between the left and right stationary contacts. An unbalance of the phase currents will cause either or both of the discs to rotate with subsequent closing of the relay trip circuit contacts. The relay trip circuit contacts are connected in parallel.

TYPES OF TESTS

Electrical Balance
Minimum Trip Setting
Operating Curve
Time Curve

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	So that the desired test current can be read in the upper 1/3 of the scale.
DC/OFF/VERNIER Switch	VERNIER
DC or AC VERNIER Control Knob	"0"

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
OUTPUT SELECT Switch	0-25A

AC AMMETER RANGE SELECTOR Switch	25A
AC ADJUST Control Knob	"0"
AC INITIATE Switch	NORMAL

TESTING ELECTRICAL BALANCE

1. Connect the 17.5A and COMMON (±) binding posts of Unit #1 to the relay's front current operating coil of one induction disc unit.

2. Connect the 0-25A and COMMON (±) binding posts of Unit #2 to the rear operating coil of the same induction disc unit.

3. Initiate unit by pressing the INITIATE Switch.

4. Rotate AC ADJUST Control Knob clockwise to obtain a reading of 6 amperes on the AC Ammeter, of Unit #2.

5. Rotate AC CONTROL Knob clockwise to obtain a reading of 6 amperes on the Ammeter of Unit #1.

6. The moving contact of the induction disc unit under test should be in a balanced position as described in relay the manufacturer's literature.

7. Return AC CONTROL Knob on Unit #1 and AC ADJUST Control Knob on Unit #2 to "0" and de-initiate the test set.

MINIMUM TRIP SETTING

1. Repeat Steps 1 through 3 under TESTING ELECTRICAL BALANCE.

2. Connect light leads from STOP/MONITOR binding posts on the test set to the trip circuit contacts of the relay.

3. Rotate AC CONTROL Knob clockwise to obtain a reading of 1 ampere on the AC Ammeter, of Unit #1.

4. Adjust the left stationary contact until it just makes with the moving contact as indicated by glowing of the CONTINUITY light or the sounding of the TONE generator.

5. Return AC CONTROL Knob to "0".

6. Rotate AC ADJUST Control Knob clockwise to obtain a reading of 1 ampere on the AC Ammeter of Unit #2.

7. Adjust right stationary contact until it just makes with moving contact, as indicated by glowing of CONTINUITY light or the sounding of the TONE generator.

8. Return AC ADJUST Control Knob to "0".

OPERATING CURVE

1. Repeat Steps 1 through 4 under TESTING ELECTRICAL BALANCE.

2. Connect light leads from STOP/MONITOR binding posts on the test set to the trip circuit contacts of the relay.

3. Rotate the AC CONTROL Knob clockwise until the moving contact and the right stationary contact make, as indicated by flickering of the CONTINUITY light. Record readings of both ammeters.

4. Slowly decrease current output of AC ADJUST Control knob by rotating it counterclockwise until the moving contact and left hand stationary contact just makes, as indicated by flickering of CONTINUITY light. Record readings of both ammeters.

TIME CURVE

1. Repeat Steps 1 through 3 under TESTING ELECTRICAL BALANCE. Set INITIATE CONTROL to MOM. position.

2. Connect a pair of light leads from STOP/MONITOR binding posts of the test set to trip circuit contact terminals of the relay.

3. "Jog" INITIATE Switch and rotate AC CONTROL Knob to obtain a reading of 10 amperes on the AC Ammeter.

4. Manually set moving contact to "Balance" position.

5. Set INITIATE CONTROL to MAINT. and the TIMER CONTROL to the INITIATE position.

6. Reset TIMER by pressing the RESET button.

7. Initiate the test set by pressing the INITIATE Switch. The unit will energize and the TIMER will initiate and when the relay contacts close, the TIMER will stop and the test set will de-energize.

8. Read and record time as indicated on the TIMER.

9. Return AC CONTROL Knob to "0". Set INITIATE CONTROL to the MOM. position.

10. "Jog" INITIATE Switch and rotate AC ADJUST Control Knob to obtain a reading of 10 amperes on AC Ammeter of Unit #2.

11. Manually set moving contact to "Balance" position.

12. Repeat steps 5 through 8 above.

Repeat all four tests, i.e. Electrical Balance, Minimum Trip Setting, Operating Curve and Time Curve for the other induction disc unit.

HIGH IMPEDANCE BUS DIFFERENTIAL RELAY
Westinghouse Type KAB

GENERAL

The type KAB relay is connected so that under normal operating conditions, the voltage at the relay terminals is approximately zero. For an external fault, assuming that neither the source or feeder C.T.'s saturate, the voltage at the relay terminals remains zero.

In the case of an internal fault, the C.T.'s have, in effect, open-circuited primaries. The source C.T.'s will produce high voltages to drive the fault current through the feeder C.T.'s secondaries. This high voltage will appear at the relay terminals and cause the relay to operate.

The overcurrent unit will operate on current flow during severe internal faults when the varistor conducts current to limit the secondary voltage.

TYPES OF TESTS

Pickup Overvoltage
Timing Overvoltage
Pickup Overcurrent
Target and Seal-In

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

SET-UP OF CONTROLS IN UNIT #1

CONTROL	POSITION
POWER ON/OFF	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	200A
DC or AC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
OUTPUT SELECT Switch	0-600V AC
AC VOLTMETER RANGE Switch	200V
AC ADJUST CONTROL Knob	"0"
AC INITIATE Switch	NORMAL
AUX ADJUST Control Knob	"0"
AUX INITIATE Switch	NORMAL
NORMAL/DROPOUT Switch	NORMAL

TESTING FOR PICKUP

1. Connect the relay potential operating coil to the Red and Black binding posts of Unit #2 at the AC/DC OUTPUT binding posts.

2. Connect light leads from binding posts marked STOP/MONITOR to the trip circuit contact terminals of the relay induction unit.

3. Initiate unit by pressing the INITIATE Switch.

4. Rotate the AUX ADJUST Control Knob clockwise to increase output until CONTINUITY light flickers or the TONE generator sounds.

5. Record this value of voltage as pickup of the relay.

TESTING TIMING

6. Initiate the V. RELAY SECTION, the NORMAL light should be illuminated, set the NORMAL relay voltage by rotating AC ADJUST Control Knob clockwise, the normal voltage is displayed in the AC VOLTMETER.

7. Switch the TIMER CONTROL to V.RLY/D.O. and set the V. RLY Test Switch to the FAULT position.

8. Set the fault voltage by rotating the AUX ADJUST Control Knob clockwise, the fault voltage is displayed in the AUX AC VOLTMETER. NOTE: Set the fault voltage approximately 1 to 2 volts higher than the desired test voltage.

9. Switch the V. RELAY Test Switch to the TEST position. The FAULT Voltage is now impressed on the relay operating coil and the TIMER will initiate.

10. When the relay trip circuit contacts make, the TIMER will stop to indicate the elapsed time of the test.

TESTING FOR PICKUP OF OVERCURRENT UNIT

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MOM.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	20A
CURRENT MEMORY/CONTINUOUS Switch	MEMORY
DC/OFF/VERNIER Switch	VERNIER
DC or AC VERNIER Control Knob	"0"

1. Connect the relay overcurrent unit operating coil to the 8.75A and the COMMON (±) of Unit #1. For the HI setting use the 35A output binding post.

2. Connect the overcurrent unit trip circuit contacts to the STOP/MONITOR binding posts of the test set.

3. Initiate unit by *holding in* INITIATE button.

4. Slowly rotate the AC CONTROL knob clockwise to increase current until the CONTINUITY light glows or TONE signal sounds. Make sure this is *minimum setting* on the AC CONTROL where the overcurrent unit of the relay will consistently pickup as the INITIATE button is alternately initiated and de-initiated.

5. Record this value of current using the CURRENT MEMORY Ammeter.

6. De-initiate test set by releasing the initiate button.

TARGET AND SEAL-IN

The DC TARGET AND SEAL-IN unit can be tested following the procedure given in the test procedures for testing an overcurrent relay.

DIFFERENTIAL VOLTAGE RELAY
General Electric Type PVD

GENERAL

This relay is a high speed bus differential relay which contains two operating units connected in parallel. One of the units (known as 87L) is an instantaneous voltage unit having a high impedance operating coil connected across the DC terminals of a full wave rectifier. The rectifier is connected in series with a reactor-capacitor combination tuned for resonance at rated frequency. The other unit (known as 87H) is an instantaneous overcurrent unit with a low impedance operating coil which is connected in series with Thyrite resistor stacks. Both of these units are connected in parallel with the secondaries of all current transformers on all the circuits associated with the bus to be protected. The current transformers on all the circuits associated with the bus to be protected. The current transformers should all have the same ratios.

The purpose of the 87L unit is to allow designation of the minimum internal fault that will operate the relay to trip all circuit breakers associated with the protected bus. The purpose of the 87H unit is to provide instantaneous operation for extremely severe internal faults.

Testing General Electric Type PVD11C Relays

NOTE: Set both the 87L and 87H units in low ranges.

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TESTING

TESTS

1. PICKUP OF 87L ELEMENT
2. PICKUP OF 87H ELEMENT
3. TESTING LEAKAGE OF THYRITE

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MOM.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER/VOLTMETER RANGE Switch	200V

DC or AC VERNIER Control knob	0
DC AMMETER RANGE Switch	5A

TESTING FOR PICKUP OF 87L ELEMENT

1. Connect the relay 87L unit operating coil to the 0-160V and COMMON (±) binding posts.

2. Connect light leads from binding posts marked STOP/MONITOR to the trip circuit contact terminals of the relay induction unit.

3. Jumper the relay terminals so that the relay 87H operating coil circuit is connected in parallel with the 87L operating coil circuit.

4. Initiate unit by pressing and holding in the INITIATE Switch.

5. Rapidly rotate the AC CONTROL Knob clockwise until the meter indicates an applied voltage approximately 25 volts higher than setting of the relay 87L unit. The CONTINUITY light should glow. Release the INITIATE Switch.

6. "Jog" the INITIATE Switch while reducing the applied voltage by rotating the AC CONTROL Knob counterclockwise. Determine minimum voltage which closed the relay 87L trip circuit contacts as indicated by the CONTINUITY light.

7. Record this value of voltage as pickup of 87L element.

TESTING PICKUP OF 87L ELEMENT

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
AC AMMETER RANGE Switch	So that the desired test current can be read in the UPPER 1/3 of the scale
DC or VERNIER Switch	VERNIER
DC or VERNIER Control Knob	"0"

DC AMMETER RANGE Switch 5A

1. Connect the appropriate current output binding posts to the relay terminals so that the operating coil of the relay 87H unit may be energized with the Thyrite resistor discs *out of the circuit.*

2. Connect the STOP/MONITOR binding posts of the test set to the trip circuit contacts terminals of the relay.

3. Initiate unit by pressing INITIATE Switch.

4. Slowly increase current to the relay operating coil by rotating AC CONTROL and AC VERNIER clockwise until CONTINUITY light glows or TONE generator sounds.

5. Record this value of current as "pickup" of the 87H unit.

TESTING THYRITE LEAKAGE

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
HORN/MONITOR Switch	Either Position
INITIATE CONTROL	MAINT.
AC CURRENT Control Knob	"0"
AC AMMETER RANGE Switch	200A
DC or VERNIER Control Switch	DC
DC AMMETER/VOLTMETER RANGE Selector	150V

1. Connect the Red (+) and Black (-) DC Output binding posts of the test set to the relay terminals so that the Thyrite resistor discs may be independently energized. A 0-15 milliampere DC meter should be connected in series with this circuit.

2. Initiate unit by pressing INITIATE Switch.

3. Rotate DC VERNIER knob clockwise to increase output to 120 volts DC.

4. Read current on milliammeter. Compare with relay manufacturer's specifications.

TESTING INSTANTANEOUS VOLTAGE RELAYS
Westinghouse Type SV, SV-1
General Electric Type PJV

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER/VOLTMETER RANGE Selector	200V
DC or AC VERNIER Control Knob	"0"
DC AMMETER/VOLTMETER RANGE Selector	5A

TESTING FOR PICKUP

1. Connect the relay operating coil to the 0-160V and COMMON (±) binding posts.

2. Connect light leads from binding posts marked STOP/MONITOR to the trip circuit contact terminals of the relay induction unit.

3. Initiate unit by pressing the INITIATE Switch.

4. Rotate the AC CONTROL Knob clockwise to increase output until CONTINUITY light flickers or the TONE generator sounds.

5. Record this value of voltage as pickup of the relay.

6. Continue to rotate AC CONTROL Knob clockwise until relay normal voltage (on relay nameplate) is read on voltmeter.

7. Rotate AC CONTROL Knob counterclockwise to decrease voltage until the CONTINUITY light just glows.

8. Read and record this value of voltage as dropout.

9. De-initiate test set and return all control knobs to "0".

PILOT WIRE RELAY
Westinghouse Type HCB

GENERAL

The HCB relay is a three-phase high speed pilot wire relay designed for simultaneous tripping at the terminals of a power line. The power line three-phase currents energize the relay operating circuits through current transformers and are converted by a combination positive and zero sequence filters into a single phase output voltage. The single-phase output voltages from the HCB relays which are located at each power line terminal, normally have polarity to cause a circulating current through the pilot wire. When a fault occurs between the terminals of the power line, polarity of the single-phase output voltages to oppose each other in the pilot wire. Therefore, the output voltage of each relay is bypassed through the relay operating coil causing relay trip circuit contact closure.

ALWAYS CONSULT THE MANUFACTURER'S INSTRUCTION LEAFLET FOR PROPER CONNECTIONS AND INFORMATION ON RELAY CHARACTERISTICS BEFORE TESTING.

TYPE OF TESTS

Phase to Neutral Pickup
Phase to Phase Pickup
Target and Seal-In Pickup

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either Position
AC CONTROL Knob	"0"
DC/VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	As desired
DC or VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

TESTING PHASE TO NEUTRAL PICKUP

1. Connect 8.75A and COMMON (±) terminals to the relay terminals designated for testing "Phase A" to Neutral.

2. Connect binding posts marked STOP/MONITOR to relay trip circuit contacts.

3. Initiate unit by pressing INITIATE Switch.

4. Slowly increase current by rotating AC CONTROL Knob and the VERNIER Control Knob clockwise until CONTINUITY light glows or TONE breaks.

5. Record this value of current as pickup.

6. Repeat for "PHASE B" to Neutral and "PHASE C" to Neutral.

TESTING PHASE TO PHASE PICKUP

Repeat Steps 1 through 6 above except that the current output is connected to the relay terminals to pass current from Phase "B" to Phase "C" in series. Repeat for Phase "C" to "A' and Phase "A" to "B".

TESTING TARGET AND SEAL-IN PICKUP

Block relay trip circuit contacts closed and follow test procedures for testing DC Target and Seal-In.

TESTING GROUND DIRECTIONAL OVERCURRENT RELAYS
Westinghouse Type IRD, KRD and
General Electric Type JBCG

PLEASE REFER TO THE MANUFACTURER'S INSTRUCTION BULLETIN BEFORE PROCEEDING WITH TEST.

TYPES OF TESTS

1. Pickup - voltage polarized directional element
2. Pickup - current polarized directional element
3. Pickup - overcurrent element
4. Timing - overcurrent element
5. Pickup - instantaneous element
6. DC TARGET
7. DC Auxiliary Switch (IRD)

TESTING PICKUP - Voltage Polarized Directional Element

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

SET-UP OF CONTROLS ON UNIT #1

POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either Position
AC CONTROL Knob	"0"
DC/OFF/VERNIER Switch	VERNIER
AC AMMETER/VOLTMETER RANGE Switch	2A
DC or AC VERNIER Control Knob	"0"
DC AMMETER/VOLTMETER RANGE Switch	5A

SET-UP OF CONTROLS ON UNIT #2

CONTROL	POSITION
0-25A/0-300V/0-600V Output Select	0-25A
AC AMMETER RANGE Switch	2A

0-25A or 0-300V AC Adjust Knob	"0"
AUX VOLTMETER RANGE Switch	2V
NORMAL/EXT.PWR. Switch	Normal
AUXILIARY ADJUST Control Knob	"0"
NORM./BYPASS Switch	NORM.
AUX. OUTPUT Voltage Selector Switch	D.E.T.
NORM./DROPOUT	NORM.

1. Connect the polarity terminal (±) of the relay's current directional unit operating coil to the Black polarity binding post (±) of the voltage AC/DC OUTPUT section. The other side of the relay's current operating coil terminal should be connected to the 0-25A Blue binding post.

2. Connect the polarity (±) terminal of the relay voltage polarizing coil to the Red binding post of the AC/DC OUTPUT section. Place a jumper from the non-polarity terminal of voltage polarizing coil to polarity (±) terminal of the current polarizing coil.

3. Set the D.E.T Selector switch to the desired position.

   NOTE: Positions 1, 2, and 3 are factory wired to produce values given below:

POSITION	VOLTS	AMPERES
1	1	2
	2	4
2	1	4
	2	8
3	1	8

4. The instantaneous element contacts on the IRD, the overcurrent element (I) contacts on the KRD relay and the (IOC) contacts on the JBCG relays should be blocked closed.

5. Connect a set of leads from the binding posts labeled STOP/MONITOR on the test set to the relay terminals associated with the normally open contacts of the directional element.

6. Initiate test set by depressing INITIATE Switch.

7. Rotate AC ADJUST Control Knob clockwise to increase output until the relay directional unit contacts close. Read and record the values of voltage and current on the respective meters.

8. Reverse test leads from test set to potential coil of relay, simulating a 180 degree phase shift. The relay's directional unit contacts should resist closure.

9. Rotate AC ADJUST Knob to "0" and de-initiate test set.

10. Remove blocking from relay.

TESTING PICKUP - Current Polarized Directional Element

1. Connect a set of test leads from the 8.75A and COMMON (±) binding posts of Unit #1 to the directional unit operating and polarizing current coils so the current will pass through the two coils in series.

   Note: This can be achieved by connecting the COMMON (±) binding post of Unit #1 the polarity (±) terminal of the directional unit current operating coil. Connect a jumper from the other side of coil to the polarity (±) terminal of the directional unit current polarizing coil. The non-polarity terminal of the polarizing coil is then connected to the 8.75A binding post of Unit #1.

2. The instantaneous element contacts on the IRD and JBCG relays and the overcurrent element (I) contacts on the KRD relay should be blocked close.

3. Connect a set of leads from the binding posts labeled STOP/MONITOR on the test set to the relay terminals associated with the normally open contacts of the directional element.

4. Initiate test set by depressing INITIATE Switch.

5. Rotate AC CONTROL and VERNIER Control Knobs clockwise to increase current output until the relay directional element contacts close. Read and record value of current on the AC Ammeter.

6. Rotate AC CONTROL and VERNIER Controls knobs to "0" and de-initiate test set.

7. *Remove blocking* from relay.

TESTING DC AUXILIARY Switch - Minimum Pickup (IRD only)

SET-UP OF CONTROLS ON UNIT #1

POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either Position
AC CONTROL Knob	"0"
DC or VERNIER Switch	DC
AC AMMETER/VOLTMETER RANGE Switch	2A
DC or AC VERNIER Control Knob	"0"
DC AMMETER/VOLTMETER RANGE Switch	150V

1. Block one of the directional elements normally open contacts closed.

2. Connect a set of leads from the Red (+) and Black (-) binding posts of the DC OUTPUT Section to the DC auxiliary switch coil terminals of the relay.

3. Initiate the test set by depressing the INITIATE Switch.

4. Rotate the DC VERNIER Control Knob clockwise to increase DC Voltage output until the auxiliary switch on the relay operates as indicated by a "click". Read and record the voltage indicated on voltmeter.

5. Rotate the DC VERNIER Control Knob to "0" and de-initiate the test set.

6. *Remove blocking* from relay.

TESTING OVERCURRENT ELEMENT - Pickup and Time Current Characteristics; INSTANTANEOUS ELEMENT - Pickup; and DC TARGET and SEAL-IN

1. Block one of the directional elements normally open contacts closed. (The IRD relay's auxiliary switch contacts must also be blocked in a closed position).

2. Follow the procedure for testing "Induction Disc Overcurrent Relay Type IAC or CO".

3. Remove all blocking from relay when testing is completed.

FAULT DETECTOR RELAY
General Electric Type CHC

GENERAL

The CHC11A relay is a three-phase, nondirectional overcurrent relay, with ground fault detection.

The CHC11B is similar to the CHC11A except it has a dual rated auxiliary telephone relay.

The CHC12A is a 3Ø, high speed, nondirectional overcurrent relay. The relay consists of a (PFD) induction CUP unit.

TYPE OF TESTS

Pickup - (PFD) Cup Unit
Pickup - (GFD) Hinged Armature Unit (11 A & B only)
Target and Seal-In

ALWAYS REFER TO THE MANUFACTURER'S LITERATURE BEFORE TEST

SET-UP OF CONTROLS ON UNIT #1

CONTROL	POSITION
POWER ON/OFF Switch	ON
INITIATE CONTROL	MAINT.
HORN/MONITOR Switch	Either Position
AC CONTROL Knob	"0"
DC or VERNIER Switch	VERNIER
AC AMMETER RANGE Switch	As Desired
DC or DC VERNIER Control Knob	"0"
DC AMMETER RANGE Switch	5A

TESTINGS PICKUP - (PFD) CUP UNIT

To test pickup of the (PFD) Cup Unit on the CHC11, it is necessary to place two phases of current in series by placing a jumper from relay terminals 4 to 6. The CHC12 requires a jumper from relay terminals 3 to 6.

1. Connect the 8.75A binding post to relay terminal 3 and the COMMON (±) binding post to relay terminal 5.

2. Perform the same test procedure as outlined under INDUCTION DISC OVERCURRENT RELAY, Pickup Test.

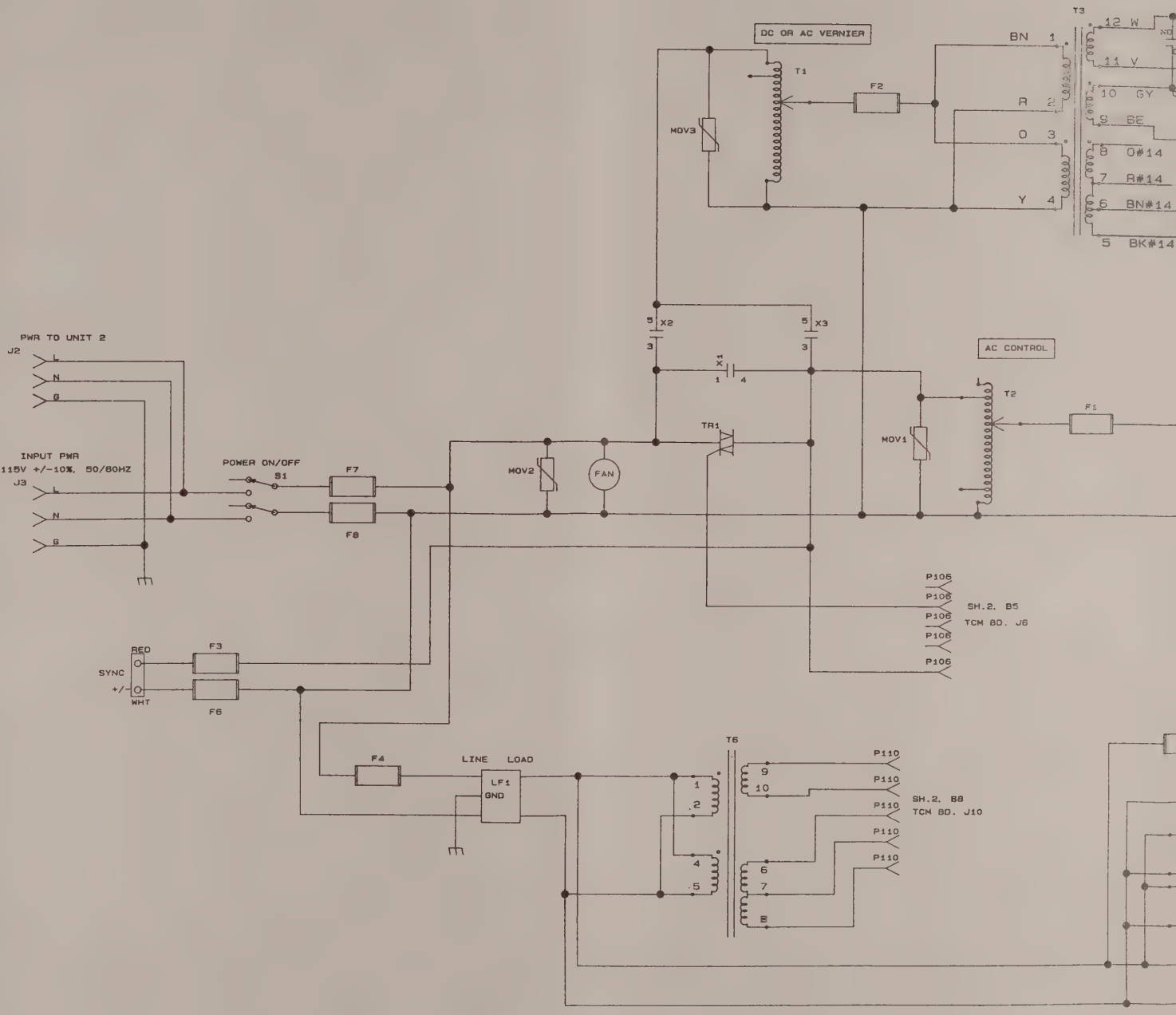
PICKUP - (GFD) HINGED ARMATURE UNIT

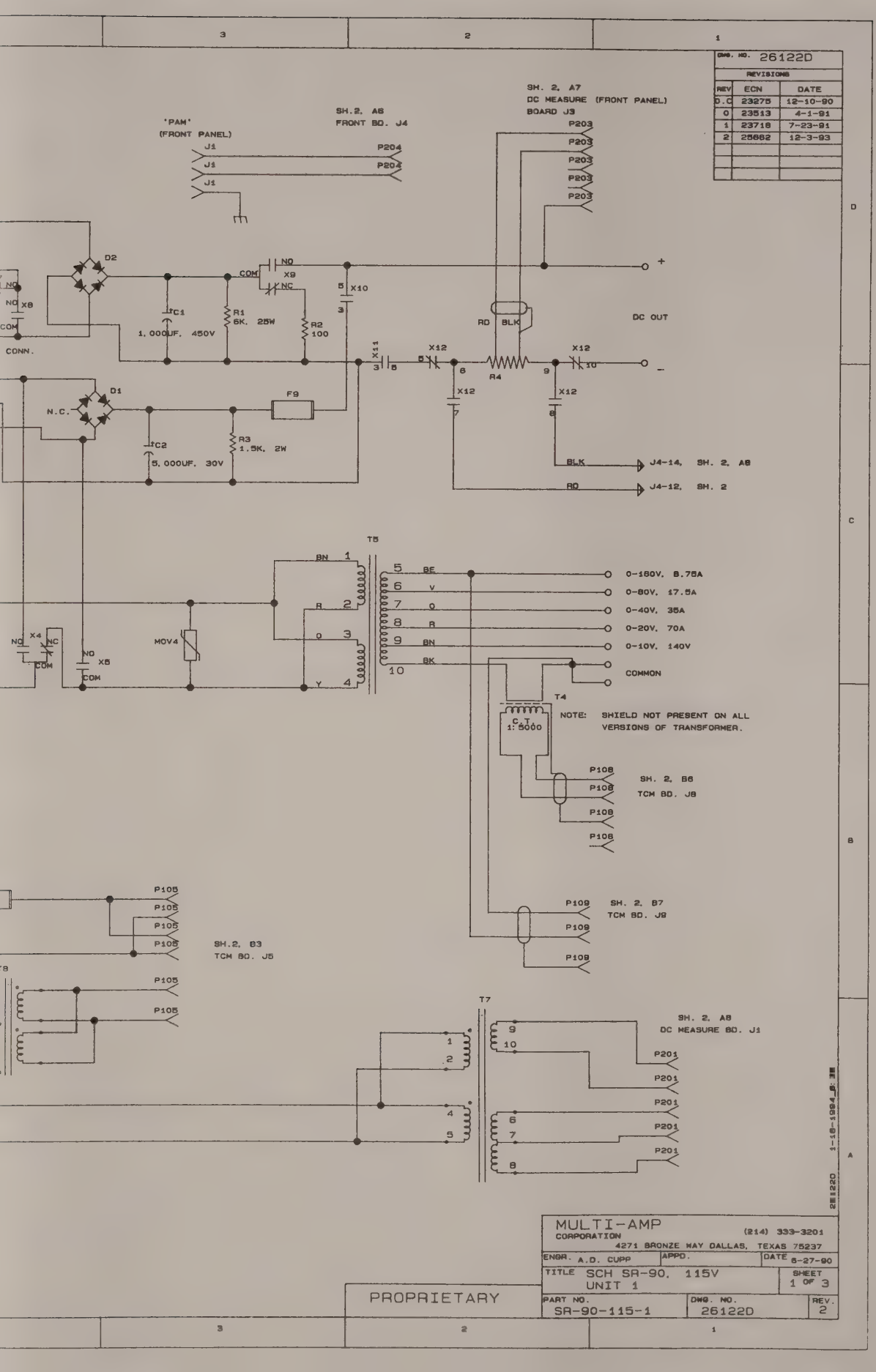
1. Perform the same test procedure as outlined under INDUCTION DISC OVERCURRENT RELAY, *Testing Instantaneous Pickup*.

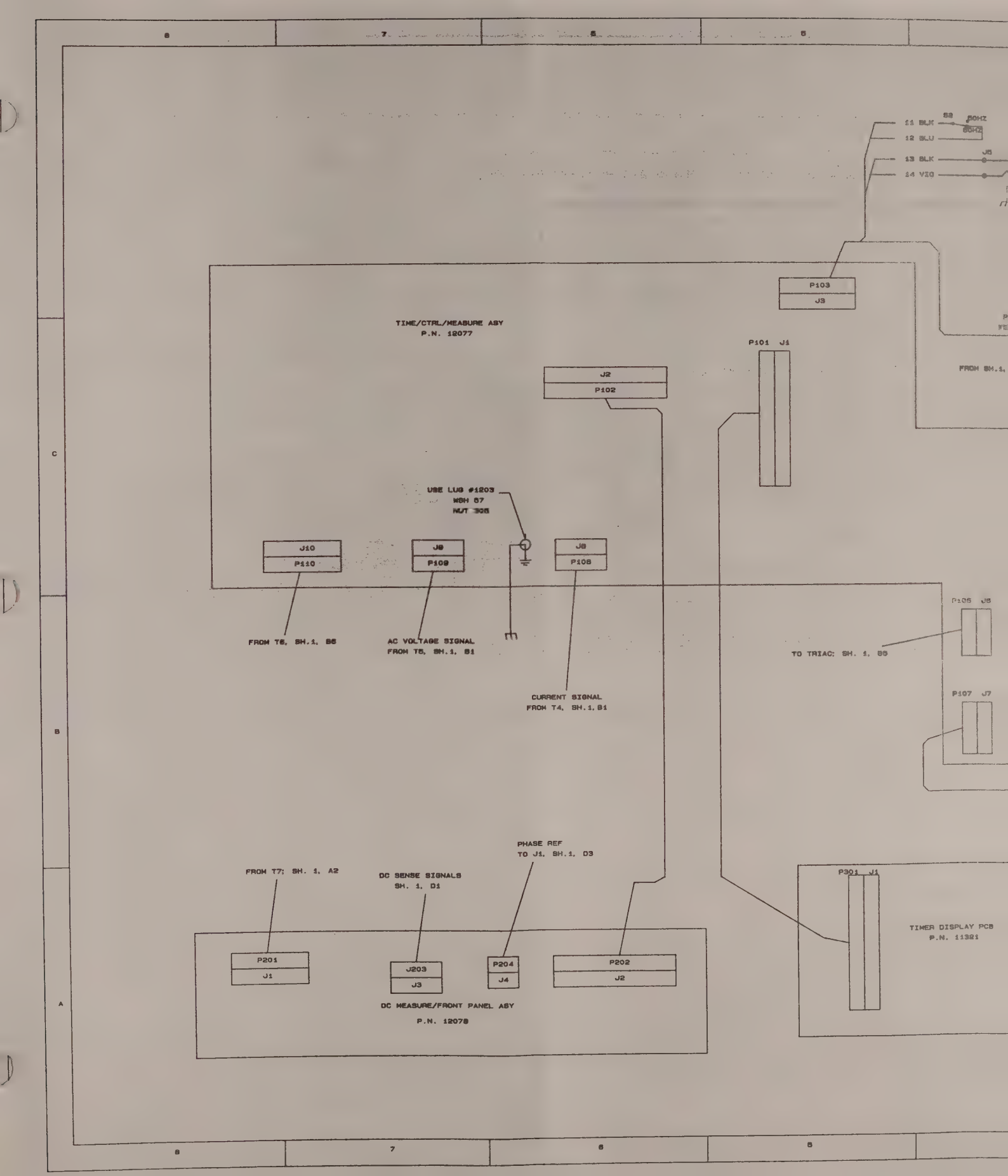
   Note: The pickup point for the GFD unit varies from only 0.5 to 8 amperes, therefore use the 8.75A output instead of the 140A output as recommended in the *Testing Instantaneous Pickup* test procedures.

TARGET AND SEAL-IN

1. Use the test procedure for testing DC Target and Seal-In relays.


DC OR AC VERNIER
T1
F2
MOV3
T3
BN 1
R 2
O 3
Y 4
12 W
11 V
10 GY
9 BE
8 O#14
7 R#14
6 BN#14
5 BK#14
X2
X3
X1
AC CONTROL
T2
F5
TR1
MOV1
PWR TO UNIT 2
J2
L
N
G
INPUT PWR
115V +/-10%, 50/60HZ
J3
POWER ON/OFF
S1
F7
F8
MOV2
FAN
P106
SH.2, B5
TCM BD. J6
RED
SYNC
+/-
WHT
F3
F6
F4
LINE
LOAD
LF1
GND
T6
P110
SH.2, B8
TCM BD. J10


DWG. NO. 26122D
REVISIONS
REV ECN DATE
D.C 23275 12-10-90
0 23513 4-1-91
1 23718 7-23-91
2 25682 12-3-93
SH. 2, A7
DC MEASURE (FRONT PANEL)
BOARD J3
SH.2, A8
FRONT BD. J4
'PAM'
(FRONT PANEL)
J1
P204
P203
D2
D1
N.C.
NO
COM
NC
X8
X9
X10
X11
X12
C1
1,000UF, 450V
R1
6K, 25W
R2
100
R3
1.5K, 2W
R4
C2
5,000UF, 30V
F9
CONN.
RD
BLK
DC OUT
+
-
J4-14, SH. 2, A8
J4-12, SH. 2
T5
BN
R
O
Y
BE
V
O
R
BN
BK
0-160V, 8.75A
0-80V, 17.5A
0-40V, 35A
0-20V, 70A
0-10V, 140V
COMMON
MOV4
X4
X5
T4
C.T.
1:5000
NOTE: SHIELD NOT PRESENT ON ALL VERSIONS OF TRANSFORMER.
P108
SH. 2, B6
TCM BD. J8
P109
SH. 2, B7
TCM BD. J9
P105
SH.2, B3
TCM BD. J5
T7
SH. 2, A8
DC MEASURE BD. J1
P201
MULTI-AMP
CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237
ENGR. A.D. CUPP
APPD.
DATE 6-27-90
TITLE SCH SR-90, 115V
UNIT 1
SHEET 1 OF 3
PROPRIETARY
PART NO. SR-90-115-1
DWG. NO. 26122D
REV. 2


11 BLK
12 BLU
13 BLK
14 VIO
S2
60HZ
50HZ
J5
P103
J3
TIME/CTRL/MEASURE ASY
P.N. 12077
P101 J1
J2
P102
FROM SH.1,
USE LUG #1203
WSH 57
NUT 325
J10
P110
J9
P109
J8
P108
FROM T6, SH.1, B6
AC VOLTAGE SIGNAL
FROM T5, SH.1, B1
CURRENT SIGNAL
FROM T4, SH.1, B1
P106 J6
TO TRIAC; SH. 1, B5
P107 J7
PHASE REF
TO J1, SH.1, D3
FROM T7; SH. 1, A2
DC SENSE SIGNALS
SH. 1, D1
P301 J1
TIMER DISPLAY PCB
P.N. 11321
P201
J1
J203
J3
P204
J4
P202
J2
DC MEASURE/FRONT PANEL ASY
P.N. 12078

DWG. NO. 26122D

EAR PANEL

EXT INIT

816
AR PNL

J4, UNIT 1 CONN. (REAR PANEL)

#	COLOR		
1	BLK		U2INITP
2	BRN		U2INITG
3	BLK		VRLY_DOP
4	RED		VRLY_DOG
5	BLK		RSTU1P
6	ORG		RSTU1G
7	BLK		HAR_RESP
8	YEL		HAR_RESG
9	BLK		MSTARSTP
10	GRN		MSTARSTG
11			
12	BLK		HR1
13			
14	BRN		HR2

X12-7

X12-8

NOTE: POLARITY MUST BE OBSERVED ON COIL OF RELAY X12

#	COLOR	RELAY
1	BLK	RLYPOS
2	BRN	X10 DC CURRENT
3	BLK	RLYPOS
4	RED	X8 150VDC (RELAY A)
5	BLK	RLYPOS
6	ORG	X9 150VDC (RELAY B)
7	BLK	RLYPOS
8	YEL	X7 300VDC
9	BLK	RLYPOS
10	GRN	X9 DC VOLTAGE
11	BLK	RLYPOS
12	BLU	X11 DC CONNECT
13	BLK	RLYPOS
14	VIO	X2 DC ON
15	BLK	RLYPOS
16	GRY	X3 VERNIER MODE
17	BLK	RLYPOS
18	WHT	X4 VERNIER MODE
19	WHT/BLK	RLYPOS
20	BRN	X5 VERNIER MODE
21	WHT/BLK	RLYPOS
22	RED	AC CURRENT ON
23		
24		
25	WHT/BLK	X12-1 (+) RLYPOS
26	ORG	X12-2 (-) MEASR H.R.

J4 P104

P/N 12817
CABLE, RELAY COILS

J5
P105

FROM T8, SH.1, B4

BINDING POSTS

PIN #		
1	BLK	START
3	RED	
5	BLK	STOP
7	RED	

26122D 1-18-1984 8:47

AVO MULTI-AMP CORPORATION (214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH., SR-90, 115V UNIT 1	2 OF 3
PART NO. SR-90-115-1	DWG. NO. 26122D REV. 2

REF. DES.	PART NO.	DESCRIPTION	QTY.
T4	12744	ASY CABLE CT SR90	1
	12686	ASY CABLE PAM SR90	1
	12667	KNOB RD BAR TYPE FEM 1/4-20	1
	12666	KNOB BK BAR TYPE FEM 1/4-20	1
	12663	ASY CABLE DC MTR INPUT SR90 1	1
	12662	ASY CABLE VOLT SIGNAL SR90	1
	12627	CABLE START/STOP SR90	1
	12626	CABLE RIB 40/C SR90	1
	12617	CABLE TCM/RLV SR90 UNIT 1	1
	12616	CABLE TCM/REAR PNL SR90 UNIT 1	1
R4	12556	RES O 0.05 15W 1% CHAS MTG	1
X2, 3, 10, 11	12186	RELAY 1PST 15A@250V 24VDC	4
TB	12103	TRANSF 115/230: 36V@.7A CT	1
C2	12102	CAP MFD 5000 30V ALUM CAN	1
C1	12101	CAP MFD 1000 450V ALUM CAN	1
T6, 7	12090	TRANSF 115/230 5 & 15 VDC	2
R1	12089	RES K 6.0 5% 25W WW FIXED	1
	12077	ASY PCB TCM SR90	1
T3	12064	TRANSF VERN DC SR90	1
T5	12063	TRANSF OUTPUT SR90 UNIT 1	1
S1	12055	SW 2PDT 20A ON-ON TCL	1
X4-9	12044	RELAY 1PST 15A 125VAC 24VDC	2
X5-8	12043	RELAY 1PST 15A NO 24VDC	4
X1	12042	RELAY 1PST 30A NO 250VAC 24VDC	1
T2	12041	KNOB 1.25 MIL GRY	1
T1	12040	KNOB 1.25 MIL GRY .25 HOLE	1
	12039	KNOB 0.7 MIL GRY .25 HOLE PNTR	2
F1-9	12036	FUSE HOLDER HTB-48I BODY BUSS	9
S2	10605	SW 2PDT ROTARY PNL MT 90DEG	1
MOV1-4	XS173	VARISTOR V130LA10A	4
R3	R1.5K0205	RES K 1.5 5% 2W	1
J5	JNL114B	CONN PHONE JACK 3 COND	1

REF. DES.
F5
F1
F3, 6, 9
F2
X12
F7, 8
FL1
T2
T1
D2
TR1
D1
F4
FAN
R2

DWG. NO. 26122D

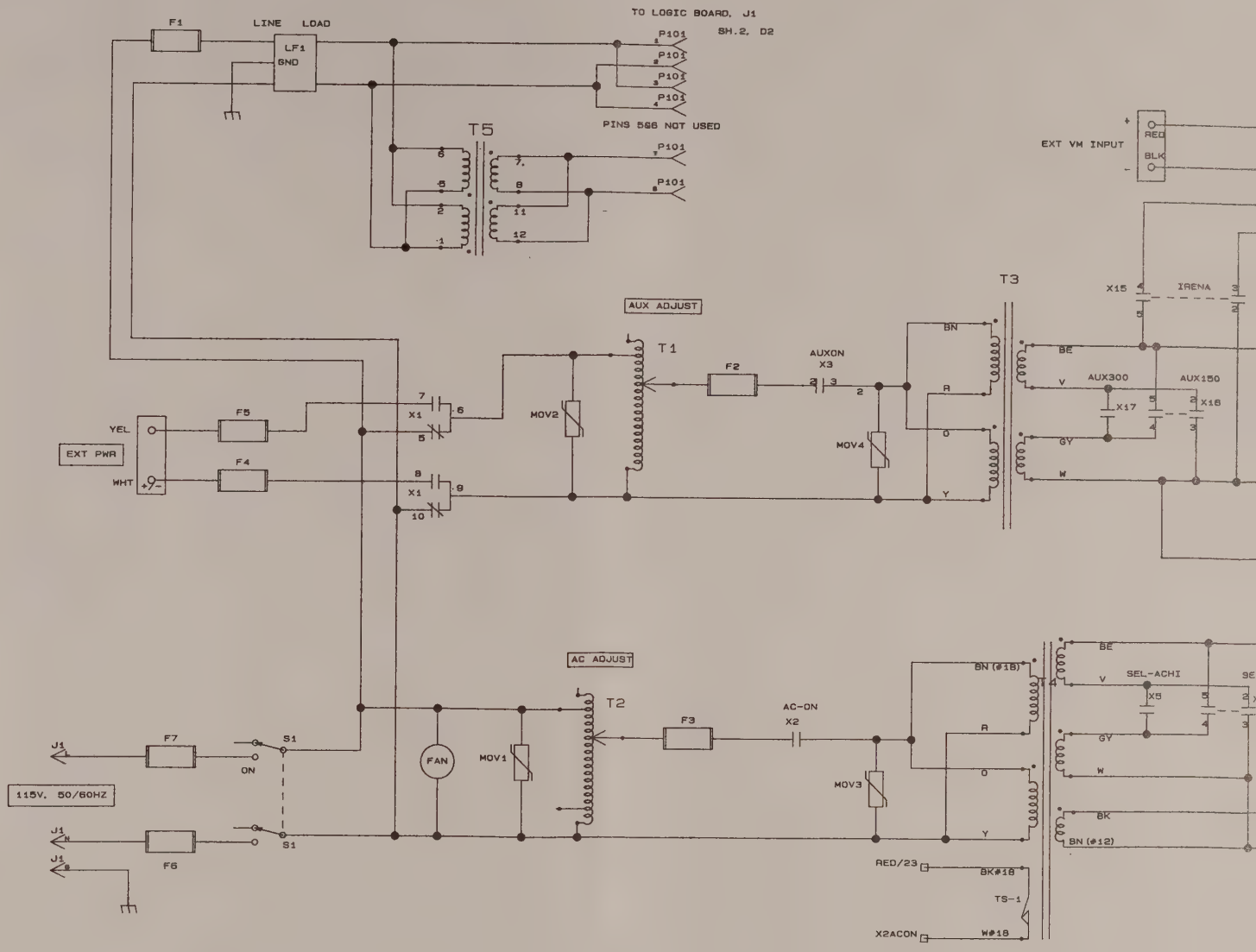
PART NO.	DESCRIPTION	QTY.
11321	ASY PCB TIMER DISPLAY	2
12078	ASY PCB DC MEASURMENT	1
982	FUSE 0.5A 250V MDL	1
963	FUSE 15A 250V MDA	1
952	FUSE 5A 250V MDA	3
951	FUSE 3A 250V MDA	1
9208	RELAY AROMAT SP2 24VDC EP	1
9043	FUSE 20A 250V MDA	2
8009	FILTER RFI 115-230V3 AMP OCR	1
610	TRANSF VAR 120V 10A	1
608	TRANSF VAR 120V 2.5A	1
5232	DIODE BRIDGE 10A 600V CHAS MT	1
4922	TRIAC 25A 600V SR76A	1
4708	DIODE BRIDGE 25A 200V CHAS MT	1
4139	FUSE 1.0A 250V MDL	1
3175	FAN 120CFM 115V 50/60 HZ	1
2183	RES 0 100 5% 12W	1

7-29-1991_16:33

MULTI-AMP CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH., SR-90, 115V, UNIT 1	3 OF 3

PART NO.	DWG. NO.	REV.
SR-90-115-1	26122D	2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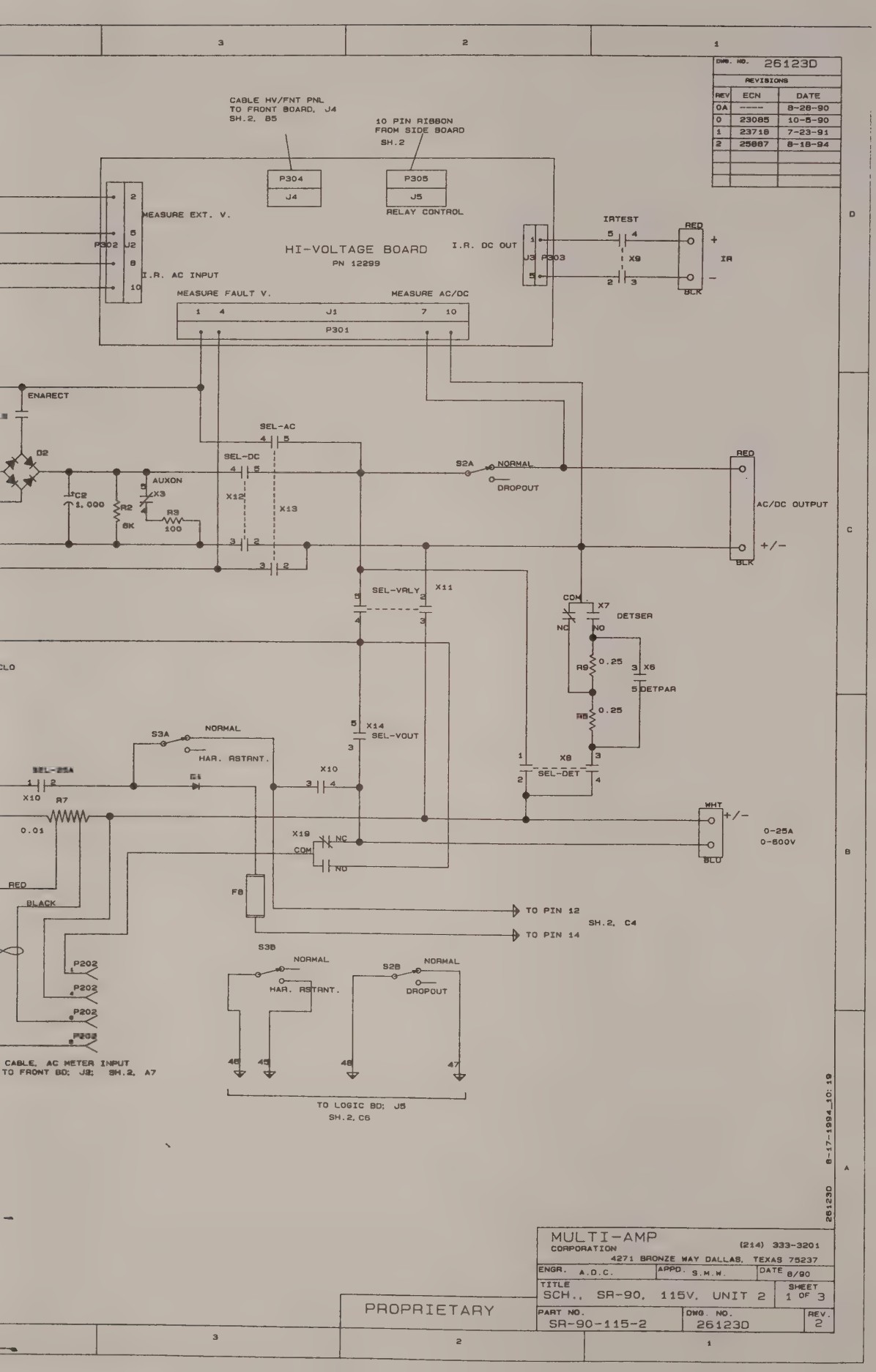
LINE
LOAD
LF1
GND
TO LOGIC BOARD, J1
SH.2, D2
P101
PINS 5&6 NOT USED
T5
EXT VM INPUT
RED
BLK
T3
X15
IRENA
AUX ADJUST
T1
F2
AUXON
X3
BN
BE
V
AUX300
AUX150
X17
X16
GY
W
F5
F4
YEL
EXT PWR
WHT
X1
MOV2
MOV4
R
O
Y
AC ADJUST
T2
F3
AC-ON
X2
J1
F7
S1
ON
115V. 50/60HZ
FAN
MOV1
MOV3
F6
BN (#18)
SEL-ACHI
X5
BK
BN (#12)
RED/23
BK#18
TS-1
X2ACON
W#18


DWG. NO. 261230
REVISIONS
REV | ECN | DATE
0A | ----- | 8-28-90
0 | 23085 | 10-5-90
1 | 23718 | 7-23-91
2 | 25887 | 8-18-94
CABLE HV/FNT PNL TO FRONT BOARD, J4 SH.2, B5
10 PIN RIBBON FROM SIDE BOARD SH.2
P304 J4
P305 J5
RELAY CONTROL
MEASURE EXT. V.
P302 J2
I.R. AC INPUT
HI-VOLTAGE BOARD
PN 12299
I.R. DC OUT
J3 P303
IRTEST
X9
RED
BLK
IR
MEASURE FAULT V.
MEASURE AC/DC
J1
P301
ENARECT
D2
C2 1.000
R2 6K
R3 100
AUXON
X3
SEL-AC
SEL-DC
X12
X13
S2A NORMAL
DROPOUT
AC/DC OUTPUT
+/-
SEL-VRLY
X11
COM.
X7
NC
NO
DETSER
R5 0.25
X6
DETPAR
R5 0.25
X8
SEL-DET
S3A NORMAL
HAR. RSTANT.
X14
SEL-VOUT
X10
R7 0.01
X19
F8
WHT
BLU
0-25A
0-600V
RED
BLACK
TO PIN 12
TO PIN 14
SH.2, C4
S3B NORMAL
HAR. RSTANT.
S2B NORMAL
DROPOUT
P202
CABLE, AC METER INPUT
TO FRONT BD; J3; SH.2, A7
TO LOGIC BD; J5
SH.2, C6
8-17-1994_10:19
261230
MULTI-AMP CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237
ENGR. A.D.C.
APPD. S.M.W.
DATE 8/90
TITLE
SCH., SR-90, 115V, UNIT 2
SHEET 1 OF 3
PART NO. SR-90-115-2
DWG. NO. 261230
REV. 2
PROPRIETARY

NOTE: POLARITY MUST BE OBSERVED ON X1
OTHER RELAYS ARE NOT POLARIZED

#	COLOR	RELAY
1	BRN/	X1-2 (-) SEL_EXT
2	BLK/	X1-1 (+) RLYPOS
3	RED/	X14 SEL_VOUT
4	BLK/	RLYPOS
5	ORG/	X10 SEL_25A
6	BLK/	RLYPOS
7	YEL/	X12 SELDC
8	BLK/	RLYPOS
9	GRN/	X18 ENARECT
10	BLK/	RLYPOS
11	BLU/	X16 AUX150
12	BLK/	RLYPOS
13	VIO/	X17 AUX300
14	BLK/	RLYPOS
15	GRY/	X5 SEL_ACHI
16	BLK/	RLYPOS
17	WHT/	X4 SEL_ACLO
18	WHT-BLK/	RLYPOS
19	BRN/	X8 SELDET
20	WHT-BLK/	RLYPOS
21	BK/	X7 DETSER
22	WHT-BLK/	RLYPOS
		X2 ACON ← W#18
24	WHT-BLK/	RLYPOS
25		NOT USED
26		

#	COLOR	RELAY
27	ORG/	X6 DETPAR
28	WHT-BLK/	RLYPOS
29	YEL/	X9 IRTEST
30	WHT-BLK/	RLYPOS
31	GRN/	X13 SELAC
32	WHT-BLK/	RLYPOS
33	BLU/	X15 IRENA
34	WHT-BLK/	RLYPOS
35	VIO/	X3 AUXON
36	WHT-BLK/	RLYPOS
37		NOT USED
38		
39	GRY/	X11 SELVRLY
40	WHT-BLK/	RLYPOS
41		NOT USED
42		
43		
44		
45	BN/	S3b-N.O.
46	WHT-BLU/	S3b-WIPER
47	BK/	S2b-N.C.
48	WHT-BLU/	S2b-WIPER
49	R/	X19 MEASNORM
50	WHT-BLU/	

SH.1, A2

FROM SH.1, B2
TB3-9
FB

P/N 12633
CABLE RELAY COIL 50C

RED/ 23 ← BK#18

FROM HI-VOLTAGE BD. J4
SH.1, D3

P/N 12635
CABLE HIV BD/F PN

P/N 12632
CABLE FPNL/CONT/PS

FROM SH.1, B4.

P203 J3 — AC DPM
P202 J2
P201 J1
P205 J5 — AUX DPM
P204 J4

MEASUREMENT BOARD
P.N. 12295

DWG. NO. 26123D

J1. UNIT 1 INTERFACE CONN.
(REAR PANEL)

#	COLOR		SIGNAL
1	BLK/	⊣	U2INITP
2	BRN/	⊣	U2INITG
3	BLK/	⊣	VALY_DOP
4	RED/	⊣	VALY_DOG
5	BLK/	⊣	RSTU1P
6	ORG/	⊣	RSTU1G
7	BLK/	⊣	HAR_RESP
8	YEL/	⊣	HAR_RESG
9	BLK/	⊣	MSTRRSTP
10	GRN/	⊣	MSTRRSTG
11			
12		⊣	HR1
13			
14		⊣	HR2

FROM SH.1, D6

CABLE, REAR PNL/ LOGIC-PS
P/N 12634

P101 J1

J2
P102

LOGIC BD.
P.N.12297

P103 J3

P/N 12665
REAR PNL/INTERFACE CONTROL

HI-VOLTAGE BD. J5
SH.1 D2

P/N 12630
CABLE RIB 10C

P104 J4

J5
P105

J6
P106

P/N 12631
CABLE RIB 60C

8-17-1994 10:08

MULTI-AMP
CORPORATION
4271 BRONZE WAY DALLAS, TEXAS 75237
(214) 333-3201

TITLE	SHEET
SCH., SR-90, 115V, UNIT 2	2 OF 3

PART NO.	DWG. NO.	REV
SR-90-115-2	26123D	2

REF. DES.	PART NO.	DESCRIPTION	QTY.
R3	2183	RES O 100 5% 12W	1
	12665	CABLE REAR PNL CONT SR90-2	1
	12664	ASY CABLE AC MTR INPUT SR90 U2	1
	12635	ASY CABLE HV/FNT PNL SR90	1
	12634	CABLE REAR PNL/CONT DS SR90	1
	12633	CABLE RELAY COIL SR90	1
	12632	CABLE FNT PNL/CONT SR90	1
	12631	CABLE RIB 60/C SR90	1
	12630	CABLE RIB 10/C SR90	1
R7	12576	RES O 0.01 1% 50W CHAS MTG	1
R8, 9	12348	RES O 0.25 25W CHAS MTG	2
	12299	ASY PCB HV PWR SUP SR90 UNIT 2	1
	12297	ASY PCB LOGIC SR90 UNIT 2	1
X6, 14	12186	RELAY 1PST 15A@250V 24VDC	2
X3	12171	RELAY 2PST 5A@250V NO/NC 24DCV	1
X8, 10	12170	RELAY 2PST 20A@250V 24DCV	2
X4, 9, 11-13	12168	RELAY 2PST 5A@250V 24DCV	7
15, 16			
T5	12103	TRANSF 115/230: 36V@.7A CT	1
C1	12101	CAP MFD 1000 450V ALUM CAN	1
R2	12089	RES K 6.0 5% 25W WW FIXED	1
T3	12066	TRANSF OUTPUT SR90	1
T4	12065	TRANSF OUTPUT SR90	1
S2	12055	SW 2PDT 20A ON-ON TCL	1
S3	12054	SW 2PDT 20A ON-OFF MOM	1
X7, 19	12044	RELAY 1PST 15A 125VAC 24VDC	2
X2, 5, 17, 18	12043	RELAY 1PST 15A NO 24VDC	4
T2	12041	KNOB 1.25 MIL GRY	1
T1	12040	KNOB 1.25 MIL GRY .25 HOLE	1
	12039	KNOB 0.7 MIL GRY .25 HOLE PNTR	3
F1-8	12036	FUSE HOLDER HTB-48I BODY BUSS	8
MOV1-4	XS173	VARISTOR V130LA10A	4

REF. DES.
S1
F6, 7
F3
F4, 5, 8
F2
F1
X1
FL1
T2
T1
D2
D1

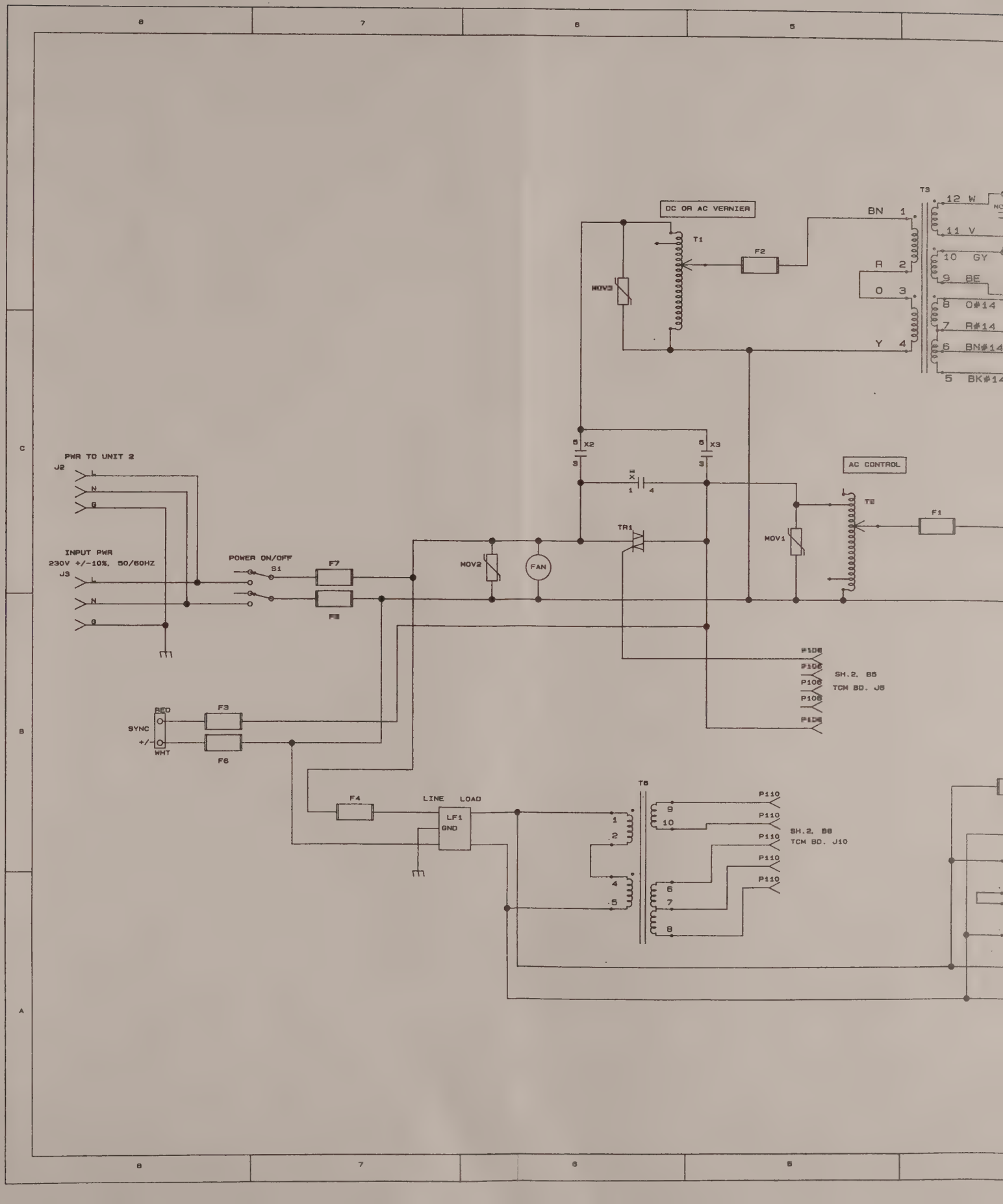
PART NO.	DESCRIPTION	QTY.
12295	ASY PCB MEASURMENT SR90 UNIT 2	1
98	SW 2PDT TOGGLE 15A	1
963	FUSE 15A 250V MDA	2
962	FUSE 8A 250V MDA	1
952	FUSE 5A 250V MDA	3
951	FUSE 3A 250V MDA	1
950	FUSE 1.5A 250V MDA	1
9208	RELAY AROMAT SP2 24VDC EP	1
8009	FILTER RFI 115-230V3 AMP OCR	1
6123	TRANSF VAR 120V 5A	1
608	TRANSF VAR 120V 2.5A	1
5232	DIODE BRIDGE 10A 600V CHAS MT	1
4708	DIODE BRIDGE 25A 200V CHAS MT	1

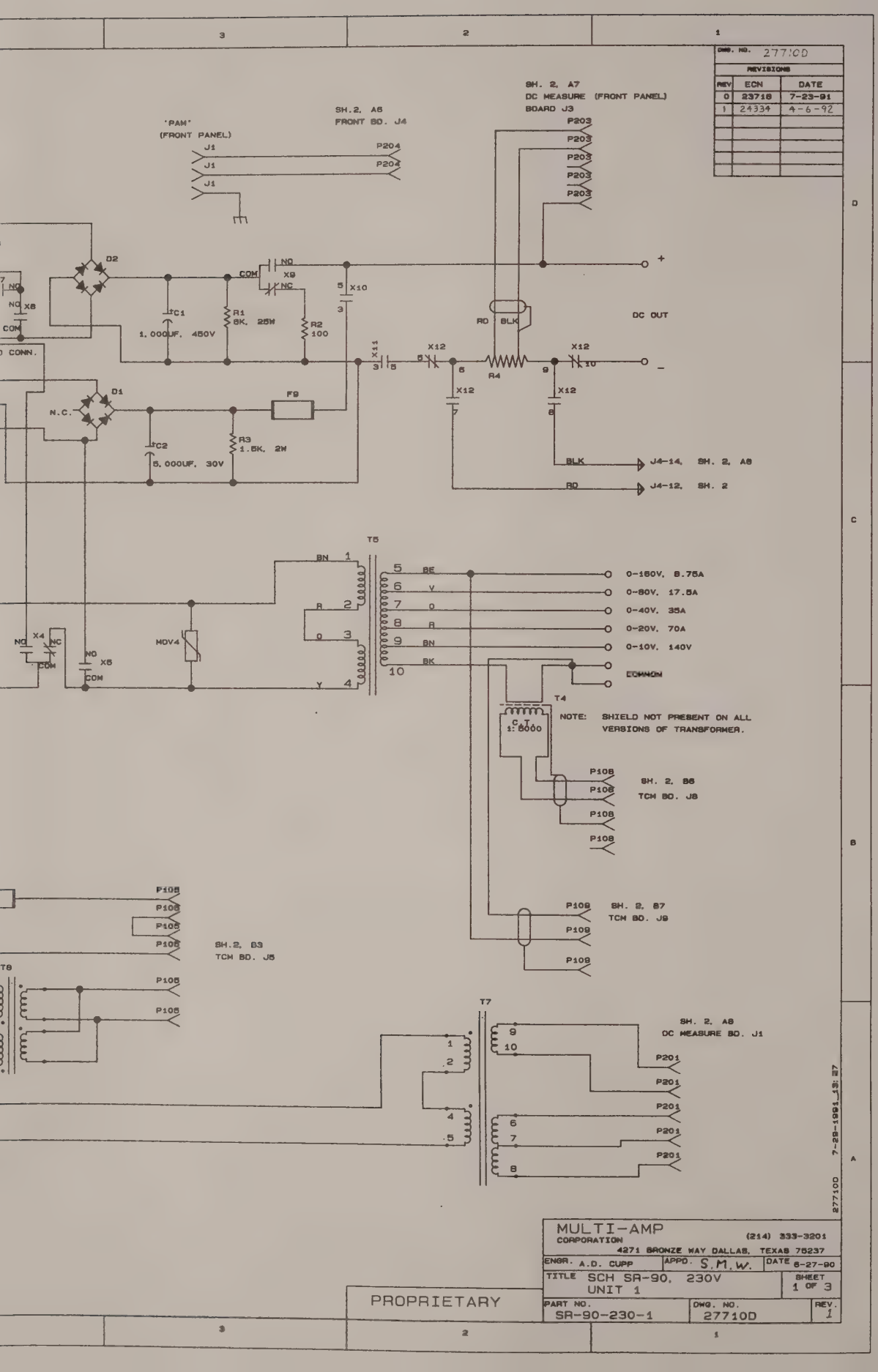
DWG. NO. 261230

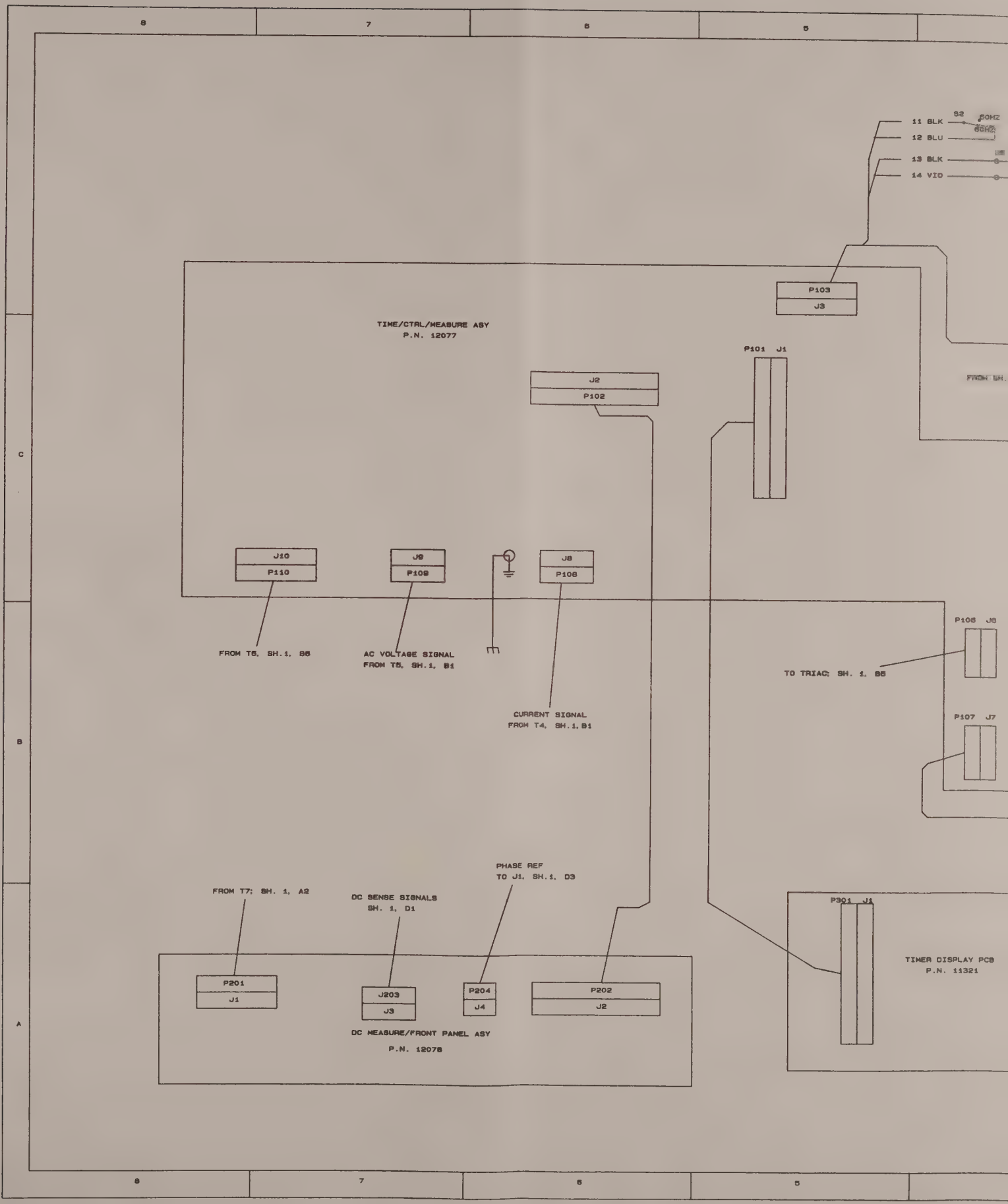
MULTI-AMP CORPORATION (214) 233-2301
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE: SCH., SR-90, 115V, UNIT 2 — SHEET 3 OF 3

PART NO. SR-90-115-2 — DWG. NO. 261230 — REV. 2


DC OR AC VERNIER
T1
F2
MOV3
T3
BN 1
R 2
O 3
Y 4
12 W
11 V
10 GY
9 BE
8 O#14
7 R#14
6 BN#14
5 BK#14
X2
X3
X1
AC CONTROL
T2
F1
TR1
MOV1
MOV2
FAN
PWR TO UNIT 2
J2
L
N
G
INPUT PWR
230V +/-10%, 50/60HZ
J3
POWER ON/OFF
S1
F7
F8
P106
SH.2, B5
TCM BD. J6
RED
SYNC
+/-
WHT
F3
F6
F4
LINE
LOAD
LF1
GND
T8
P110
SH.2, B8
TCM BD. J10


DWG. NO. 27710D
REVISIONS
REV | ECN | DATE
0 | 23718 | 7-23-91
1 | 24334 | 4-6-92
SH. 2, A7
DC MEASURE (FRONT PANEL)
BOARD J3
SH.2, A6
FRONT BD. J4
"PAM"
(FRONT PANEL)
J1
P204
P203
D2
D1
N.C.
C1
1,000UF, 450V
C2
5,000UF, 30V
R1
8K, 25W
R2
100
R3
1.5K, 2W
R4
RD BLK
DC OUT
F9
X4
X5
X6
X9
X10
X11
X12
MOV4
T5
BN
R
O
Y
BE
V
O
R
BN
BK
0-160V, 8.75A
0-80V, 17.5A
0-40V, 35A
0-20V, 70A
0-10V, 140V
COMMON
T4
1:8000
NOTE: SHIELD NOT PRESENT ON ALL VERSIONS OF TRANSFORMER.
P108
SH. 2, B6
TCM BD. J8
SH. 2, B7
TCM BD. J9
P109
SH.2, B3
TCM BD. J5
P105
T9
T7
SH. 2, A8
DC MEASURE BD. J1
P201
BLK
J4-14, SH. 2, A8
RD
J4-12, SH. 2
7-23-1991 13:27
27710D
MULTI-AMP
CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237
ENGR. A.D. CUPP
APPD. S.M.W.
DATE 6-27-90
TITLE SCH SR-90, 230V
UNIT 1
SHEET 1 OF 3
PART NO. SR-90-230-1
DWG. NO. 27710D
REV. 1
PROPRIETARY


11 BLK
12 BLU
13 BLK
14 VID
S2
50HZ
60HZ
P103
J3
TIME/CTRL/MEASURE ASY
P.N. 12077
P101 J1
J2
P102
FROM SH.
J10
P110
J9
P109
J8
P108
FROM T5, SH.1, B6
AC VOLTAGE SIGNAL
FROM T5, SH.1, B1
CURRENT SIGNAL
FROM T4, SH.1, B1
P106 J6
TO TRIAC; SH. 1, B5
P107 J7
PHASE REF
TO J1, SH.1, D3
FROM T7; SH. 1, A2
DC SENSE SIGNALS
SH. 1, D1
P201
J1
J203
J3
P204
J4
P202
J2
DC MEASURE/FRONT PANEL ASY
P.N. 12078
P301 J1
TIMER DISPLAY PCB
P.N. 11321

DWG. NO. 27710D

REAR PANEL

EXT INIT

2516
EAR PNL

J4, UNIT 1 CONN. (REAR PANEL)

#	COLOR		
1	BLK	─<	U2INITP
2	BRN	─<	U2INITG
3	BLK	─<	VRLY_DOP
4	RED	─<	VRLY_DOG
5	BLK	─<	RSTU1P
6	ORG	─<	RSTU1G
7	BLK	─<	MAR_RESP
8	YEL	─<	MAR_RESG
9	BLK	─<	MSTARSTP
10	GRN	─<	MSTARSTG
11			
12	BLK	─<	HR1
13			
14	BRN	─<	HR2

X12-7

X12-8

NOTE: POLARITY MUST BE OBSERVED ON COIL OF RELAY X12

#	COLOR		RELAY
1	BLK	─<	RLYPOS
2	BRN	─<	X10 DC CURRENT
3	BLK	─<	RLYPOS
4	RED	─<	X6 150VDC (RELAY A)
5	BLK	─<	RLYPOS
6	ORG	─<	X8 150VDC (RELAY B)
7	BLK	─<	RLYPOS
8	YEL	─<	X7 300VDC
9	BLK	─<	RLYPOS
10	GRN	─<	X9 DC VOLTAGE
11	BLK	─<	RLYPOS
12	BLU	─<	X11 DC CONNECT
13	BLK	─<	RLYPOS
14	VIO	─<	X2 DC ON
15	BLK	─<	RLYPOS
16	GRY	─<	X3 VERNIER MODE
17	BLK	─<	RLYPOS
18	WHT	─<	X4 VERNIER MODE
19	WHT/BLK	─<	RLYPOS
20	BRN	─<	X5 VERNIER MODE
21	WHT/BLK	─<	RLYPOS
22	RED	─<	AC CURRENT ON
23			
24			
25	WHT/BLK	─<	X12-1 (+) RLYPOS
26	ORG	─<	X12-2 (-) MEASR H.R.

J4 P104

P/N 12817
CABLE, RELAY COILS

J5
P105

FROM T8, SH.1, B4

BINDING POSTS

PIN #			
1	BLK	START	
3	RED		
5	BLK	STOP	
7	RED		

27710D 7-24-1991 9:09

MULTI-AMP CORPORATION (214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH., SR-90, 230V UNIT 1	2 OF 3

PART NO.	DWG. NO.	REV.
SR-90-230-1	27710D	1

	12686	ASY CABLE PAM SR90	1
	12667	KNOB RD BAR TYPE FEM 1/4-20	1
	12666	KNOB BK BAR TYPE FEM 1/4-20	1
	12663	ASY CABLE DC MTR INPUT SR90 U1	1
	12662	ASY CABLE VOLT SIGNAL SR90-1	1
	12628	CABLE RIB 26/C	1
	12627	CABLE START/STOP SR90	1
	12626	CABLE RIB 40/C SR90	1
	12617	CABLE TCM/RLV SR90 UNIT 1	1
	12616	CABLE TCM/REAR PNL SR90 UNIT 1	1
R4	12556	RES 0 0.05 15W 1% CHAS MTG	1
X2, 3, 10, 11	12186	RELAY 1PST 15A@250V 24VDC	4
T8	12103	TRANSF 115/230: 36V@.7A CT	1
C2	12102	CAP MFD 5000 30V ALUM CAN	1
C1	12101	CAP MFD 1000 450V ALUM CAN	1
T6, 7	12090	TRANSF 115/230 5 & 15 VDC	2
R1	12089	RES K 6.0 5% 25W WW FIXED	1
	12077	ASY PCB TCM SR90	1
T3	12064	TRANSF VERN DC SR90	1
T5	12063	TRANSF OUTPUT SR90 UNIT 1	1
S1	12055	SW 2PDT 20A ON-ON TGL	1
X4, 9	12044	RELAY 1PST 15A 125VAC 24VDC	2
X5-8	12043	RELAY 1PST 15A NO 24VDC	4
X1	12042	RELAY 1PST 30A NO 250VAC 24VDC	1
T2	12041	KNOB 1.25 MIL GRY	2
T1	12040	KNOB 1.25 MIL GRY .25 HOLE	1
	12039	KNOB 0.7 MIL GRY .25 HOLE PNTR	2
F1-9	12036	FUSE HOLDER HTB-48I BODY BUSS	9
FAN	11334	FAN 120CFM 230V 50/60 HZ	1
S2	10605	SW 2PDT ROTARY PNL MT 90DEG	1
R3	R1.5K0205	RES K 1.5 5% 2W	1
J5	JNL114B	CONN PHONE JACK 3 COND	1
REF. DES.	PART NO.	DESCRIPTION	QTY.

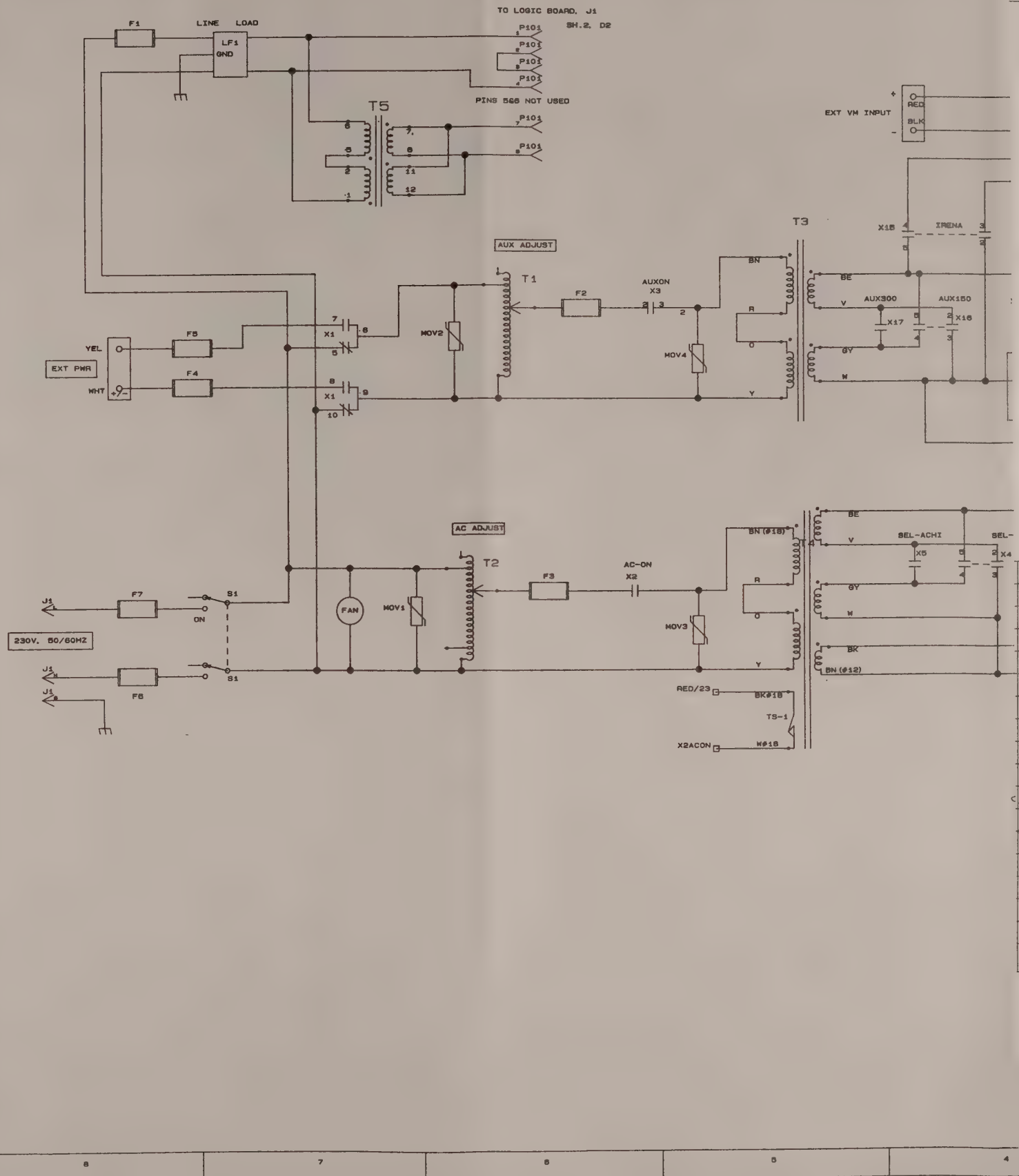
F1, 7, 8
F3, 6
F4, 5
F9
F2
T2
X12
MOV1-4
FL1
T2
D2
TR1
D1
T1
R2
T4
REF. DES.

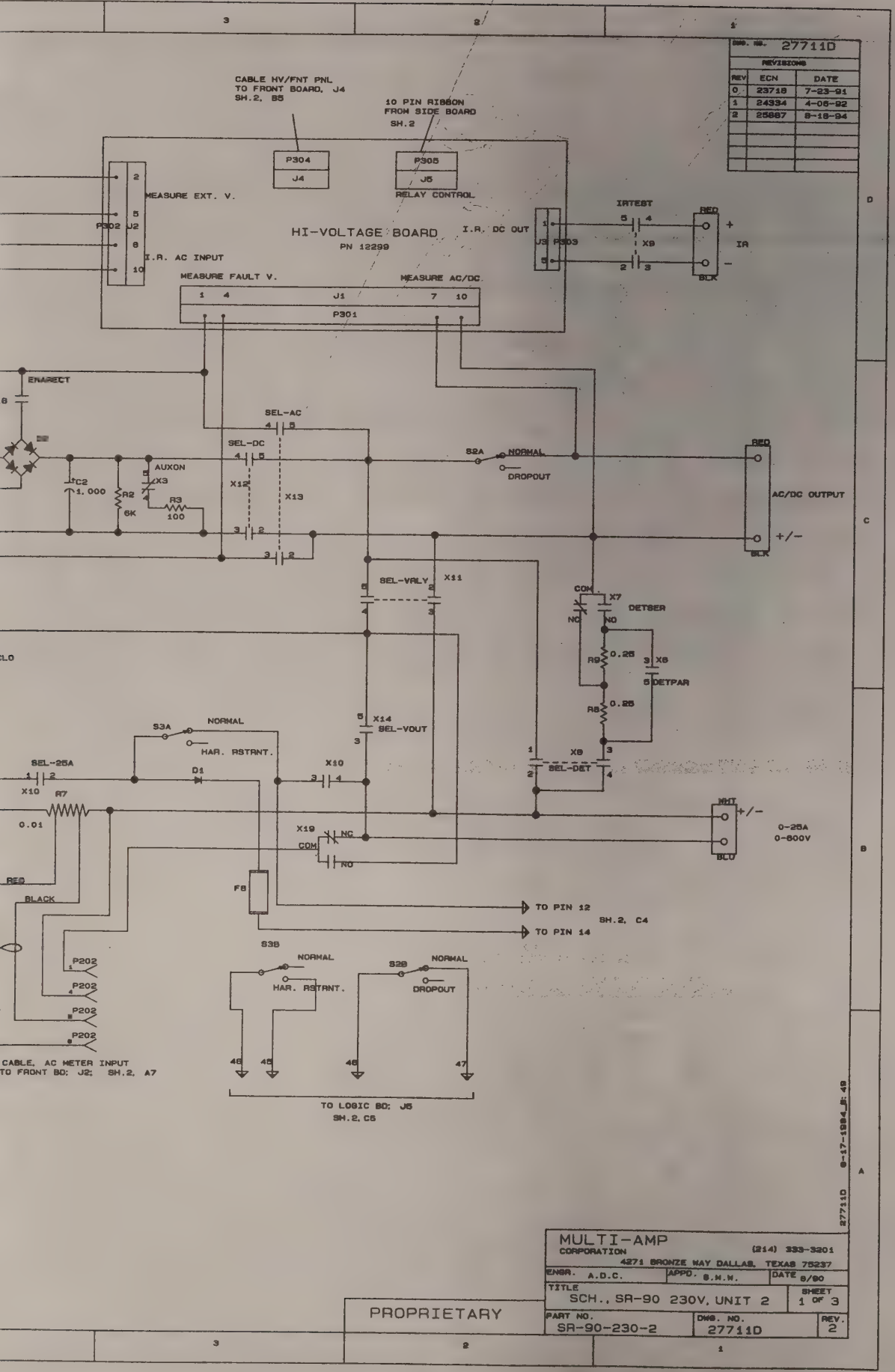
	12078	ASY PCB DC METER SR90	1
	11321	ASY PCB TIMER DISPLAY	1
	984	FUSE 10A 250V MDA	3
	983	FUSE 2.0A 250V MDA	2
	982	FUSE 0.5A 250V MDL	2
	952	FUSE 5A 250V MDA	2
	950	FUSE 1.5A 250V MDA	1
	9494	TRANSF VAR 250V 2.5A SUP	1
	9208	RELAY AROMAT SP2 24VDC EP	1
	8888	VARISTOR 320V	4
	8009	FILTER RFI 115-230V3 AMP OCR	1
	639	TRANSF VAR 240V 3.5A	1
	5232	DIODE BRIDGE 10A 600V CHAS MT	1
	4922	TRIAC 25A 600V SR76A	1
	4708	DIODE BRIDGE 25A 200V CHAS MT	1
	3294	TRANSF VAR 240V 0.5A SUP	1
	2183	RES O 100 5% 12W	1
	12744	ASY CABLE CT SR90	1
	12696	ASY CABLE SR90 U1	2
	PART NO.	DESCRIPTION	QTY.

DWG. NO. 27710D

MULTI-AMP CORPORATION (214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH.. SR-90, 230V, UNIT 1	3 OF 3
PART NO. SR-90-230-1	DWG. NO. 27710D
	REV. 1


TO LOGIC BOARD, J1
SH.2, D2
F1
LINE
LOAD
LF1
GND
P101
PINS 5&6 NOT USED
T5
EXT VM INPUT
RED
BLK
T3
X15
IRENA
AUX ADJUST
T1
F2
AUXON
X3
BN
R
O
Y
BE
V
GY
W
AUX300
AUX150
X17
X16
MOV2
MOV4
YEL
EXT PWR
WHT
F5
F4
X1
AC ADJUST
T2
F3
AC-ON
X2
SEL-ACHI
X5
X4
FAN
MOV1
MOV3
J1
F7
S1
ON
230V, 50/60HZ
F6
BK
BN(#18)
BN(#12)
RED/23
BK#18
TS-1
X2ACON
W#18


DWG. NO. 27711D
REVISIONS
REV ECN DATE
0 23718 7-23-91
1 24334 4-06-92
2 25887 8-18-94
CABLE HV/FNT PNL TO FRONT BOARD, J4 SH.2, B5
10 PIN RIBBON FROM SIDE BOARD SH.2
P304 J4
P305 J5
RELAY CONTROL
MEASURE EXT. V.
P302 J2
I.R. AC INPUT
HI-VOLTAGE BOARD
PN 12299
I.R. DC OUT
J3 P303
IRTEST
X9
RED
BLK
IR
MEASURE FAULT V.
MEASURE AC/DC
J1
P301
ENARECT
SEL-AC
SEL-DC
X12
X13
AUXON
X3
C2 1.000
R2 6K
R3 100
S2A NORMAL
DROPOUT
AC/DC OUTPUT
+/-
SEL-VRLY
X11
COM.
X7
DETSER
NC
NO
R9 0.25
X6
DETPAR
R8 0.25
X14
SEL-VOUT
X9
SEL-DET
S3A NORMAL
HAR. RSTRNT.
SEL-25A
X10
D1
R7 0.01
WHT
BLU
0-25A
0-600V
X19
F8
TO PIN 12
SH.2, C4
TO PIN 14
S3B NORMAL
HAR. RSTRNT.
S2B NORMAL
DROPOUT
P202
CABLE, AC METER INPUT
TO FRONT BD: J2; SH.2, A7
TO LOGIC BD: J5
SH.2, C5
MULTI-AMP CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237
ENGR. A.D.C.
APPD. S.M.W.
DATE 8/90
TITLE
SCH., SR-90 230V, UNIT 2
SHEET 1 OF 3
PART NO. SR-90-230-2
DWG. NO. 27711D
REV. 2
PROPRIETARY

NOTE: POLARITY MUST BE OBSERVED ON X1
OTHER RELAYS ARE NOT POLARIZED

COLOR		RELAY
BRN/	1	X1-2 (-) SEL_EXT
BLK/	2	X1-1 (+) RLYPOS
RED/	3	X14 SEL_VOUT
BLK/	4	RLYPOS
ORG/	5	X10 SEL_25A
BLK/	6	RLYPOS
YEL/	7	X12 SELDC
BLK/	8	RLYPOS
GRN/	9	X18 ENARECT
BLK/	10	RLYPOS
BLU/	11	X16 AUX150
BLK/	12	RLYPOS
VIO/	13	X17 AUX300
BLK/	14	RLYPOS
GRY/	15	X5 SEL_ACHI
BLK/	16	RLYPOS
WHT/	17	X4 SEL_ACLO
WHT-BLK/	18	RLYPOS
BRN/	19	X8 SELDET
WHT-BLK/	20	RLYPOS
BK/	21	X7 DETSER
WHT-BLK/	22	RLYPOS
		X2 ACON W#18
WHT-BLK/	24	RLYPOS
	25	
	26	NOT USED

COLOR		RELAY
ORG/	27	X6 DETPAR
WHT-BLK/	28	RLYPOS
YEL/	29	X9 IRTEST
WHT-BLK/	30	RLYPOS
GRN/	31	X13 SELAC
WHT-BLK/	32	RLYPOS
BLU/	33	X15 IRENA
WHT-BLK/	34	RLYPOS
VIO/	35	X3 AUXON
WHT-BLK/	36	RLYPOS
	37	NOT USED
	38	
GRY/	39	X11 SELVRLY
WHT-BLK/	40	RLYPOS
	41	NOT USED
	42	
	43	
	44	
BN/	45	S3b-N.O.
WHT-BLU/	46	S3b-WIPER
BK/	47	S2b-N.C.
WHT-BLU/	48	S2b-WIPER
		SH.1, A2
R/	49	X19 MEASNORM
WHT-BLU/	50	

FROM SH.1, B2
TB3-9
F8

P/N 12633
CABLE RELAY COIL 50C

RED/23 — BK#18

FROM HI-VOLTAGE BD. J4
SH.1, D3

P/N 12635
CABLE HIV BD/F PN

P/N 12632
CABLE FPNL/CONT/PS

FROM SH.1, B4.

P203 J3 — AC DPM
P202 J2
P201 J1
P205 J5 — AUX DPM
P204 J4

MEASUREMENT BOARD
P.N. 12295

DWG. NO. 27711D

J1. UNIT 1 INTERFACE CONN.
(REAR PANEL)

#	COLOR		SIGNAL
1	BLK/	⊣	U2INITP
2	BRN/	⊣	U2INITG
3	BLK/	⊣	VRLY_DOP
4	RED/	⊣	VRLY_DOG
5	BLK/	⊣	RSTU1P
6	ORG/	⊣	RSTU1G
7	BLK/	⊣	HAR_RESP
8	YEL/	⊣	HAR_RESG
9	BLK/	⊣	MSTRRSTP
10	GRN/	⊣	MSTRRSTG
11			
12		⊣	HR1
13			
14		⊣	HR2

FROM SH.1, D6

CABLE, REAR PNL/ LOGIC-PS
P/N 12634

P101 J1

J2
P102

LOGIC BD.
P.N.12297

P103 J3

P/N 12665
REAR PNL/INTERFACE CONTROL

HI-VOLTAGE BD. J5
SH.1 D2

P/N 12630
CABLE RIB 10C

P104 J4

J5
P105

J6
P106

P/N 12631
CABLE RIB 60C

8-17-1984 8:48
27711D

MULTI-AMP
CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH.. SR-90, 230V UNIT 2	2 OF 3

PART NO.	DWG. NO.	REV.
SR-90-230-2	27711D	2

	12665	CABLE REAR PNL CONT SR90-2	1
	12664	ASY CABLE AC MTR INPUT SR90 U2	1
	12667	KNOB RD BAR TYPE FEM 1/4-20	1
	12635	ASY CABLE HV/FNT PNL SR90	1
	12634	CABLE REAR PNL/CONT DS SR90	1
	12633	CABLE RELAY COIL SR90	1
	12632	CABLE FNT PNL/CONT SR90	1
	12631	CABLE RIB 60/C SR90	1
	12630	CABLE RIB 10/C SR90	1
R7	12576	RES O 0.01 1% 50W CHAS MTG	1
R8, 9	12348	RES O 0.25 25W CHAS MTG	2
	12299	ASY PCB HV PWR SUP SR90 UNIT 2	4
X6, 14	12186	RELAY 1PST 15A@250V 24VDC	2
X3	12171	RELAY 2PST 5A@250V NO/NC 24DCV	1
X8, 10	12170	RELAY 2PST 20A@250V 24DCV	2
X4, 9, 11-13	12168	RELAY 2PST 5A@250V 24DCV	7
15, 16			
T5	12103	TRANSF 115/230: 36V@.7A CT	1
C1	12101	CAP MFD 1000 450V ALUM CAN	1
R2	12089	RES K 6.0 5% 25W WW FIXED	1
T3	12066	TRANSF OUTPUT SR90	1
T4	12065	TRANSF OUTPUT SR90	1
S2	12055	SW 2PDT 20A ON-ON TCL	1
S3	12054	SW 2PDT 1A ON-OFF TCL MOM	1
X7, 19	12044	RELAY 1PST 15A 125VAC 24VDC	2
X2, 5, 17, 18	12043	RELAY 1PST 15A NO 24VDC	4
T2	12041	KNOB 1.25 MIL GRY	1
T1	12040	KNOB 1.25 MIL GRY .25 HOLE	1
	12039	KNOB 0.7 MIL GRV .25 HOLE PNTR	3
F1-8	12036	FUSE HOLDER HTB-48I BODY BUSS	8
F6, 7	11848	FUSE 7A 250V MDL	2
FAN	11334	FAN 120CFM 230V 50/60 HZ	1
REF. DES.	PART NO.	DESCRIPTION	QTY.

F4, 5
F1
S1
F3, 8
F2
T2
X1
MOV1-4
FL1
D2
D1
R3
REF. DES.

	3	2	1

DWG. NO. 27711D

12297	ASY PCB LOGIC	1
12295	ASY PCB MEASURMENT	1
983	FUSE 2.0A 250V MDA	2
982	FUSE 0.5A 250V MDL	1
98	SW 2PDT TOGGLE 15A	1
952	FUSE 5A 250V MDA	2
950	FUSE 1.5A 250V MDA	1
9494	TRANSF VAR 250V 2.5A SUP	1
9208	RELAY AROMAT SP2 24VDC EP	1
8888	VARISTOR 320V	4
8009	FILTER RFI 115-230V3 AMP OCR	1
5232	DIODE BRIDGE 10A 600V CHAS MT	1
4708	DIODE BRIDGE 25A 200V CHAS MT	1
3294	TRANSF VAR 240V 0.5A SUP	1
2183	RES 0 100 5% 12W	1
PART NO.	DESCRIPTION	QTY.

D C B A

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MULTI-AMP CORPORATION
(214) 333-3201
4271 BRONZE WAY DALLAS, TEXAS 75237

TITLE	SHEET
SCH., SR-90, 230V, UNIT 2	3 OF 3

PART NO.	DWG. NO.	REV.
SR-90-230-2	27711D	2

	3	2	1